POWER

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Buckle Down

It was the noon hour, and the machinery in the great power house was still. The men, after finishing their midday meal, had formed into little groups. Some were gossiping, some disposing of the problems of the day according to their own particular ideas. The superintendent was leaning against a pillar, idly watching the smoke rise from his pipe. Near-by two men were talking earnestly. As their conversation waxed warmer, their raised voices brought their words plainly to the superintendent's ears.

"It's no use to try to get ahead," said one, moodily. "There's no chance for a man these days. I've worked here four years, and the other day when they wanted a foreman, they gave the job to a fellow who hadn't been here two. Ain't I as good as he is? Sure I am. I was here the longest and I ought to have had the job."

The superintendent walked slowly toward the men and stopped in front of them.

"Boys," he said, "I don't want to butt in, but I couldn't help hearing what you said just now, and I want to tell you something that happened to me.

"I came to these works ten years ago as a machine hand. I learned the ropes a little, and for three years I worked steadly. Then the foreman left and I applied for the job. I didn't get it, though. Another man went over my head. It gave me a shock, for I was pretty sure I'd get the job. I had been here the longest of any man in the shop, and I thought I was entitled to it for that reason alone.

"Then I began to ask myself why I had been turned down. The answer was plain. I had been on the job every day for three years, but I hadn't done a bit more than was asked me to do, and I hadn't learned to do anything but my special work. One night I took stock of myself; the result wasn't pleasing. I made up my mind if I was going to advance I had got to do something to make myself worthy of promotion.

"Then I buckled down to work. Five nights a week I went to a school, where I learned about electrical and steam engineering, shop practice and drafting, and things that I needed to know in my line.

"You can bet it was hard work after being in the shop all day, and many a time I was tempted to give it up. But I was ambitious and had my eye on the foreman's job, so I kept on. Often the boys would call me a fool for devoting my evenings to study instead of enjoying myself as most of them did.

"Well, I kept it up for two years and had just started on my third year when the foreman left. Boys, I didn't have to apply for the job that time. They offered it to me. I don't want to boast, but I'm superintendent of the whole plant because I was 'fool' enough to fit myself for the job.

"Beg your pardon, boys, for butting in, but when I heard you complaining about not getting ahead, I thought I'd tell you how I did it. There's only one way and that's to buckle down, get busy, and—"

Just then the whistle blew, the men went to their places, and the great wheels began to revolve once more. And all the afternoon you could hear them say, amidst the whir and noise:

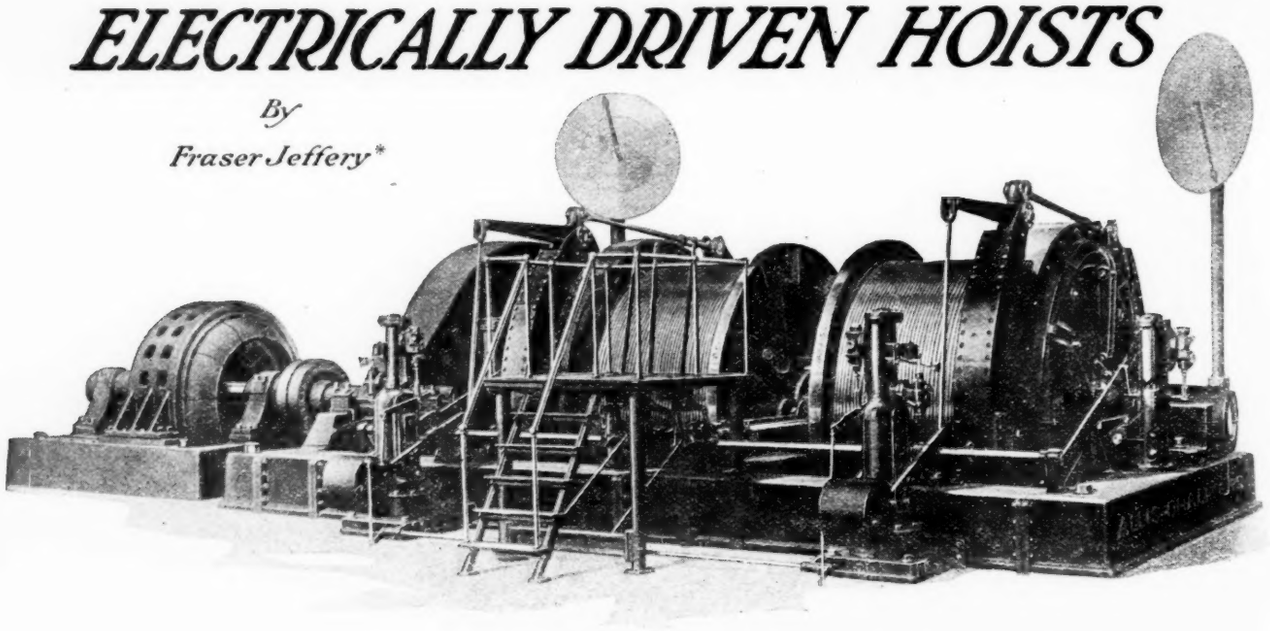
"Buckle down! Buckle down! Buckle down!"

Contributed by Frank Dorrance Hopley.

ELECTRICALLY DRIVEN HOISTS

By

Fraser Jeffery*



Unbalanced single-drum hoisting and the more efficient balanced hoist employing a second cage or a counterweight. The character of load imposed by different types of hoist and different hoisting depths. Prevalent use of slip-ring induction motor. Details of electric braking and a comparison of full magnetic and liquid control.

ELECTRIC motors are fast superseding the steam engine for the operation of hoists. This is due to a great extent to the comparative ease with which electric energy can now be transmitted to the districts where the mines, quarries, etc., are located and to the greater convenience and economy of the electric motor over the steam engine.

The usual function of any hoist is to elevate material. The material may be moved either in a vertical shaft or on an incline, and the work may be accomplished by means of a "balanced" or an "unbalanced" hoist.

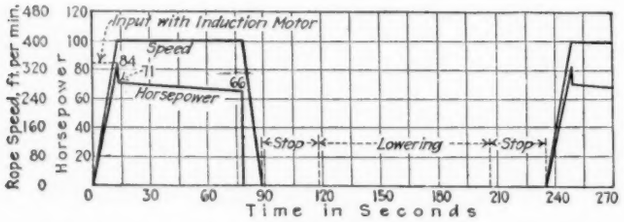


FIG. 1. PERFORMANCE OF SINGLE-DRUM HOIST OPERATING IN SHAFT 500 FEET DEEP

For the balanced hoisting the arrangement usually consists of two drums on a common shaft (see headpiece) or two drums on parallel shafts driven by a common pinion. Each drum is preferably driven through a clutch so that the relative position of the drums, hence the skips or cages, can be changed.

For unbalanced hoisting the arrangement generally consists of a single drum on which the hoisting rope is wound in one or more layers, as in Fig. 4. The drum may be keyed to the shaft supporting it or connected by means of a clutch. With the former arrangement the driving motor and gearing naturally revolve in lowering, while with the latter only the drum turns. When the hoist is operated unbalanced, the energy expended in hoisting the skip or cage, together with the car and rope, is wasted. Since the weight of these parts frequently amounts to more than the useful load hoisted, the efficiency with an unbalanced load is necessarily low.

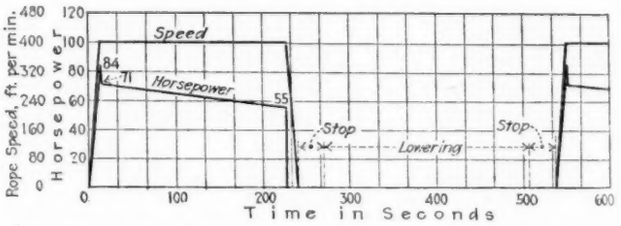


FIG. 2. PERFORMANCE OF HOIST, FIG. 1, WITH SHAFT DEPTH INCREASED TO 1,500 FEET

To increase the efficiency of hoists by the elimination of these losses, two skips or cages are arranged in balance, one to ascend while the other descends, the ascending skip or cage being loaded and the descending one being empty. This is known as the "balanced" hoist. Two skips or cages operating in this manner require two-compartment shafts. With a single-compartment shaft similar results may be obtained by using a counterweight, and in this manner the ascending skip or cage can be properly balanced. The counterweight is taken generally to equal in weight, one-half of the live load plus the dead load. This method of counterbalancing gives the same load on the driving motor when hoisting the material as when hoisting the counterweight.

There are numerous modifications to either of the foregoing types of hoists, each in its way affecting the power required to do the work. This necessitates a close investigation of each condition to be met. A study of Figs. 1, 2 and 3 will give some idea as to the kind of load imposed upon a motor by different kinds of hoists

*Electrical Engineer, Allis-Chalmers Manufacturing Co., Milwaukee.

working under the same conditions and for different hoisting depths.

In Fig. 1 a single-drum "unbalanced" hoist is assumed, having a maximum rope pull of 5000 lb. with a rope speed of 400 ft. per min. and a shaft depth of 500 feet. If the rope diameter is ¾ in., making the weight of the rope 440 lb., a total weight of 4560 lb. of skip or cage and material to be hoisted is permitted. If full speed is reached in 13 seconds, the curve of torque over time will be as shown. It will be noticed that the peak of the load is extremely high compared with

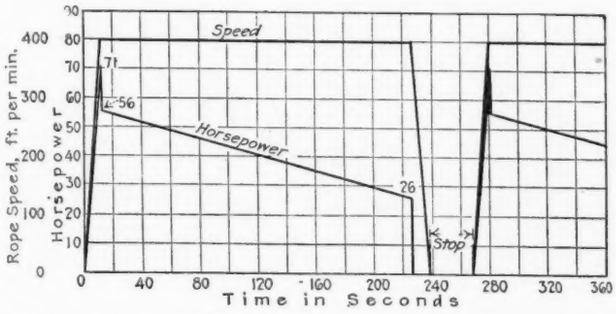


FIG. 3. PERFORMANCE OF BALANCED HOIST OPERATING IN SAME SHAFT AS FIG. 2

the average load and that the motor is in service only a short part of the total time, the rest period of the motor being formed by two stops and the lowering period, in addition to the small amount of time required for braking.

Fig. 2 shows the performance of this same hoist when used for hoisting from a 1500 ft. depth instead of 500 ft. Since the rope now weighs 1320 lb., the combined weight of skip or cage and material to be moved cannot be more than 3680 lb. The beginning of the load curve will be the same as for Fig. 1, until the 1000-ft. level is reached, when the combined weight of the cage, material and rope is equal to the weight of the cage and material in Fig. 2. After this the load will continue to decrease at the same rate as before until the top is reached, at which time the rope pull will be equal to the weight of the cage and material alone, or 3680 lb. The rest period of the motor now covers a smaller percentage of the total time than before, because the time of stops remains constant.

Consider this same hoist operating in "balance," which would be the case if a second drum and a second skip or cage were added to the equipment. The load due to the descending skip or cage and rope must be deducted from that due to the ascending skip or cage, material and rope, and a certain amount must be added during the acceleration period, which will be higher than the corresponding amount with the single-drum hoist, in proportion to the larger masses to be accelerated. Fig. 3 shows the performance under these conditions when hoisting from a 1500-ft. depth. It is obvious that the rest period of the motor with the "balanced" hoist is much shorter than with the "unbalanced" hoist, since no lowering is done by gravity, a load being hoisted every trip.

It is seen from the foregoing that the operating conditions of a hoist are not only intermittent, but the rope pull varies continually during the hoisting period. Therefore, the capacity of the driving motor must be selected according to the peak during acceleration and according to the heating of the motor when performing its cycle of operation at the regular intervals. This latter is determined by calculating the "root mean square" values of the load over the operating cycle.

With very large hoists the problem of furnishing power for a service of comparatively small average power demand with intermittent peaks sometimes becomes serious. Where the prime-mover equipment and the line conditions are such that intermittent fluctuations in load are permissible, the alternating-current slip-ring type of induction motor is invariably used. Direct-current motors are not so often used, mainly for the reason that the distribution of power is almost always by means of alternating current. For the hoisting conditions prevalent in this country the induction motor is used most extensively, while the number of direct-current installations is limited more or less to special applications or to conditions where the size of the unit is such as to demand a smoothing out of the load peaks.

If the reduction of line peaks becomes necessary, a system involving the use of flywheels for storing energy has been resorted to. Briefly, it comprises a direct-current hoist motor and a motor-generator set consisting of a

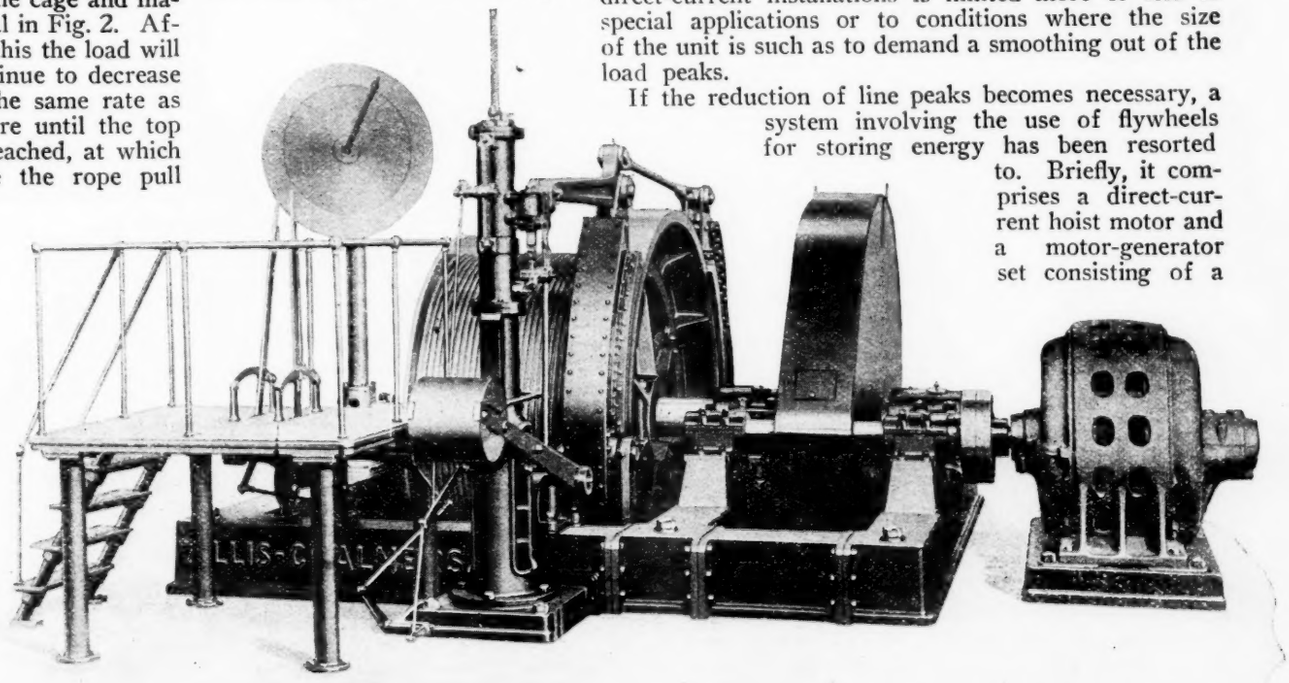


FIG. 4. UNBALANCED SINGLE-DRUM HOIST GEARED TO INDUCTION MOTOR

direct-current generator driven by a motor which is usually of the alternating type, and equipped with a flywheel. To avoid the starting losses inherent with any type of resistance control, voltage regulation between the direct-current generator and the hoist motor is used. By proper field control, there are times when the hoist motor may be advantageously operated as a generator and the generator of the flywheel set as a motor, thus returning energy to the flywheel and reducing the power demand from the line. This is commonly known as "dynamic braking" and is resorted to at the time when ordinary braking would occur. This is usually taken care of by the motor-control lever actuating the automatic control, and in this way a simplified means is provided the operator for performing an otherwise complicated function.

With the alternating-current induction motor a means of braking, commonly called "electric braking," is frequently resorted to. It is used mostly in places where hoisting is done on long inclines and more with the "unbalanced" type of hoist than with the "balanced" hoist. In such an arrangement the motor revolves during the lowering period. Under these conditions and at this particular time, if the motor, with all external secondary resistance cut out and secondary winding short-circuited, is thrown across the line, the weight of the descending parts tends to operate the motor above synchronous speed. This action is such as to return energy to the line and to develop a counter-torque sufficient to act as an effective brake, thus not only reducing the power demand, but increasing the longevity of the friction brakes. This functioning is also taken care of in a simplified manner to facilitate ease of handling for the operator.

In addition to a careful analysis of load cycles and selection of the proper size of driving motor, the question of control is of considerable importance. As brought out before, the direct-current installations are limited to more or less special applications and to the large hoists where the question of line peaks is likely to become serious. In general, the slip-ring type of induction motor predominates for the average hoist installation, therefore it would seem logical to give some data on the control for this type of machine rather than to describe some one special direct-current application.

Outside of the usual drum-type controller in use with the smaller hoist motors up to about 100 hp., there is a choice between the full-magnetic type of control and the liquid type of control. The magnetic control consists of a master switch or lever, Fig. 5, in the hands of the operator. This switch, for different positions, actuates relays mounted on a separate panel, as in Fig. 6, and in this manner controls the primary and secondary circuits, the speed, direction of rotation and the torque of the induction motor by opening or closing the primary switches and by cutting in or cutting out resistance in the secondary circuit.

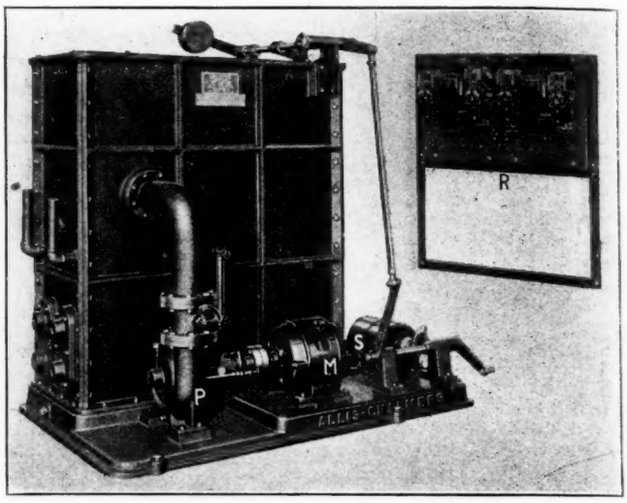


FIG. 7. LIQUID RHEOSTAT AND MAGNETICALLY OPERATED REVERSING SWITCHES

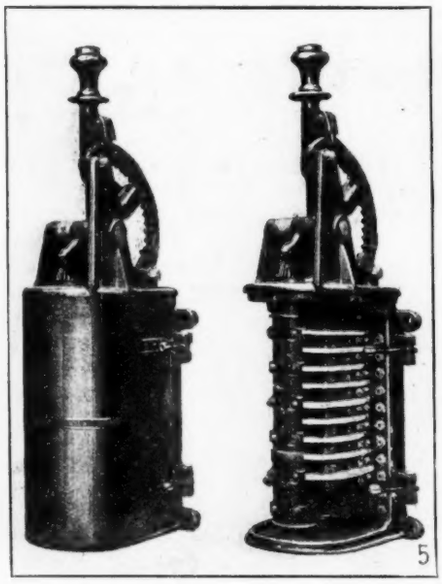


FIG. 5. MASTER SWITCH FOR CONTROLLER PANEL

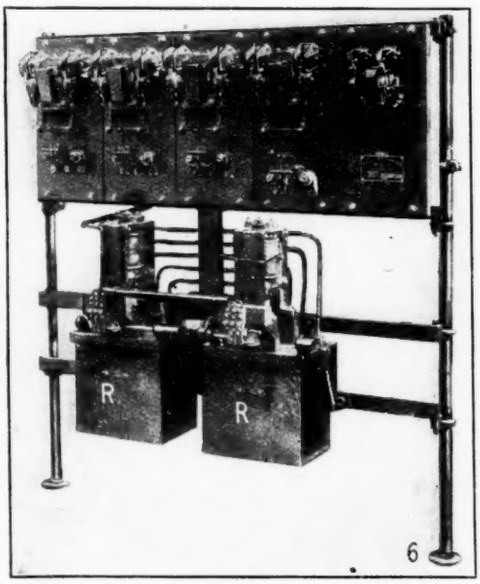


FIG. 6. ELECTRICALLY DRIVEN HOIST CONTROL PANEL

For the liquid control, Fig. 7, the equipment consists essentially of two parts—a primary reversing-switch mechanism and a tank for the control of the secondary circuit. The primary of the motor is controlled by two magnetically operated reversing switches *R*, as shown on the small panel, interlocked so that only one can close at a time. This type of primary reversing switch is used for motors up to 550 volts. For higher voltages high-tension reversing oil switches, such as are shown at *R* and *R* in Fig. 6, are substituted.

The tank for the secondary control is divided into an upper and a lower compartment. The lower compartment is the storage and cooling tank for the electrolyte, which is pure water in which a certain amount of sodium carbonate has been dissolved. In the upper compartment the electrodes, consisting of a set of plates connected in each phase of the induction-motor's secondary circuit, are suspended from an insulated support. The amount of resistance in the secondary cir-

cuit, and consequently the speed and the torque of the motor, are governed by the height of the electrolyte in the upper compartment. This in turn is regulated by means of a multiple-shutter type weir located at one end of the upper compartment and controlled directly by the hand lever in the operator's pulpit. The opening and closing of the weirs regulates the height of the electrolyte.

Only one hand lever is used to operate the controller for both forward and reverse directions of rotation of the motor. The direction in which the hand lever is moved from the central, or "off," position determines the direction of rotation of the motor. The first movement of the operating lever from the central forward position actuates a small master switch *S*, which is mounted on the base of the tank, as shown in Fig. 7. This master switch closes the primary switch for forward direction of the hoist motor. The remaining travel of the hand lever gradually closes the weir, causing the electrolyte to rise, thereby cutting out resistance and bringing the motor up to speed. Returning the lever to the central position opens the weir, which in turn lowers the level of the electrolyte, inserting resistance in the rotor circuit and opening the primary switch, thus cutting off current entirely from the motor. By moving the lever in the opposite direction, the same cycle is obtained except for the reverse direction of the hoist motor. The small motor *M* on the base of the tank, Fig. 7, operates a pump *P* and constantly circulates the electrolyte from the lower to the upper compartment. It is thus seen that with the weirs closed the electrolyte level will rise, but with the weirs open it will remain at low level such as to insert full resistance in the secondary circuit of the motor.

For the smaller sizes of motors of 100 hp. and up to 300 hp. the full-magnetic type of control, such as is shown in Fig. 6, has been used extensively. For motors of this size the first cost of the magnetic control, not considering installation cost, is lower than that of the liquid control. The cost of installing the magnetic control is, however, greater than that of the liquid control. It is generally conceded that for smoothness of acceleration and minimum line disturbance, especially for the larger sizes of hoist motors, the liquid control is preferable. The following citation of an actual installation first using magnetic control, then changing to liquid control, will bring out some of these points.

A large coal and coke company had in operation a double-drum hoist equipped with a 350-hp. 550-volt 60-cycle slip-ring induction motor governed by a contractor-type magnetic control. The hoist operated two cages in balance in a vertical shaft, the approximate hoisting distance being 500 ft., and a trip was made every 30 seconds. The power for the hoist was supplied from the coal company's central station, where a 2500-kw. turbine carried the load of all the mines. In addition to the various hoisting loads there were some fairly large pump motors and small rotary converters.

On account of the rapidity of the trips, the accelerating peaks on the hoist motor were naturally high and amounted to approximately 720-hp. torque. This caused considerable line disturbance, which was further augmented by the action of the magnetic controller, being amplified as each successive switch closed. The line fluctuations when the hoist was operating were so great that the flickering of the incandescent lamps was pronounced.

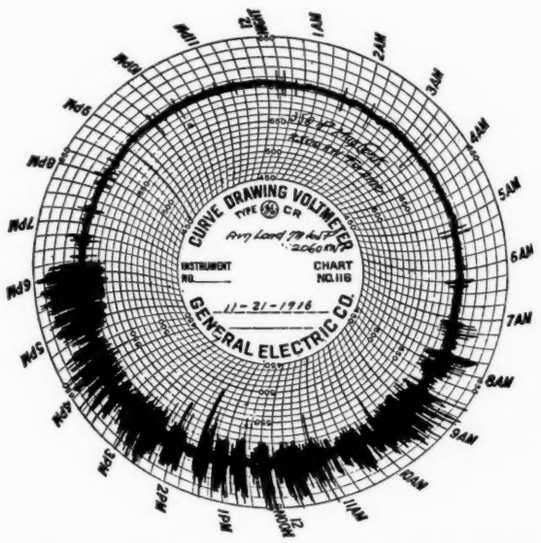


FIG. 8. VOLTAGE CHART WITH 350-HP. MOTOR OPERATED WITH MAGNETIC CONTROL

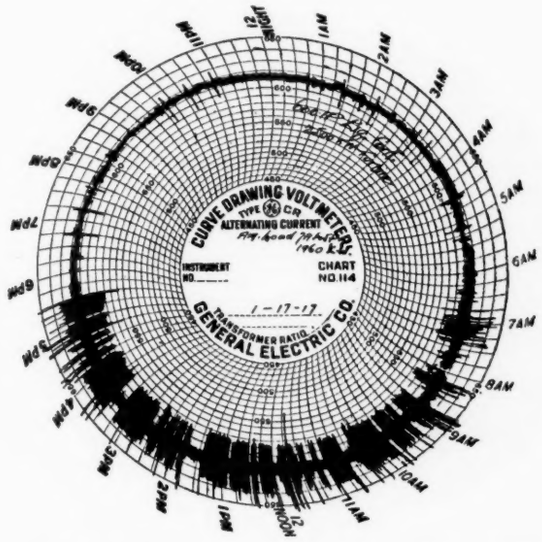


FIG. 9. VOLTAGE CHART WITH 600-HP. MOTOR OPERATED WITH LIQUID CONTROL

It was decided to increase the output of the mine by speeding up this particular hoist so as to make a trip in 22 seconds. Calculations show that the new conditions would require a 600-hp. hoist motor and that the peaks at acceleration would amount to approximately 1000 hp. torque. On account of the increased peak load, serious consideration was given to the advisability of using an equalizer flywheel set instead of an induction motor. This would have involved large first cost, considerably more floor space and a longer time of shutdown to make the change. After a careful analysis of all the operating conditions, it was finally decided to install a 600-hp. slip-ring type induction hoist motor with a liquid controller.

The two voltage charts, Figs. 8 and 9, were taken from the recording meter on the switchboard of the coal company's power plant. Chart, Fig. 8, was taken when the 350-hp. motor with magnetic control was operating the hoist just before the change was made. Chart, Fig. 9, was taken after the hoist had been speeded up and was being operated by the 600-hp. motor with liquid control. The marked regularity of

operation obtained with the liquid controller is noticeable. This is due to the gradual and uniform acceleration with the liquid type. The actual peaks at acceleration under the new conditions amounted to nearly 1200-hp. torque, but even with the greater peak the sudden voltage fluctuation was less than obtained with the 720-hp. torque peak and the smaller motor. The acceleration with the liquid type of control is so gradual that the governor on the steam turbine has time to pick up and follow the load variations and respond to the line demand.

The change resulted in the elimination of the flickering of the incandescent lights. A graphic meter with minute feed would have shown more clearly that the voltage fluctuations in the case of chart, Fig. 9, were gradual and uniform rather than sudden and instantaneous, as was the case of chart, Fig. 8, but such a meter was not available at the time the tests were made.

The Origin of Petroleum

Many different authorities have given different reasons for the origin of petroleum. The question, however, has now come down to a controversy between the advocates of the theory which supposes petroleum to be of inorganic origin, and those who claim it to be of organic origin. The latter by far predominate.

In the year 1794 Haquet suspected that the oils of Galicia came from marine mussels "dissolved" in salt water. Many eminent geologists have accepted this theory. The assumption is that decomposition of these organic bodies took place at comparatively low temperature and high pressure. It is interesting to note that in a paper before the Institute of Mining Engineers, 1914, Dr. Hans von Höfer, of Vienna, states that C. Engler tested his (Höfer's) thesis experimentally by heating in retorts under a pressure of ten atmospheres and to a temperature of from 300 to 400 deg. C., first fish oil, and afterward fishes and mussels. He obtained in this way a product very like petroleum.

Some geologists assign an animal origin to the nitrogeneous California petroleum and a vegetable origin to the nonnitrogeneous oils of Pennsylvania. The greatest defender of the organic-origin theory in America is Eugene Coste, of Toronto, who sees in petroleum the product of "volcanic solfataric emanation."

The following is from a paper by Coste before the New York meeting of the Institute of Mining Engineers, February, 1914:

> Sedimentary strata are composed of alternate beds of shales, sandstones and limestones, most of which are sufficiently close-grained to have retained from the time of their deposition enough water held in their minute pores by capillary action to fill all the spaces between their grains and render them entirely impervious to other fluids. Shales or consolidated clays form the bulk of the sediment, and are especially fine-grained saturated impervious rock, but many beds of sandstone or limestone are also quite impervious. A sufficient proof is the very strong natural gas pressures always recorded in the gas and oil deposits and the great difference in the pressure of the gas of different sands tapped at different depths of the same well or in near-by wells in the same pool or field.
>
> To explain the retention of this gas under strong pressures (up to 1500 lb. per sq.in. in some cases) in so many thousands of separate spots and at depths sometimes as shallow as 100 ft. and varying from that to 4000 ft., we must certainly conclude that the sedimentaries forming the substrata of this vast region and ranging through many geological ages, are remarkably impervious. It is for this reason that the petroleum deposits have not escaped to the surface and have been preserved in a multitude of separate pockets, pools or fields with different pressures, though often quite close to one another and always comparatively near the surface.

Prof. Edward Orton, in his report on the occurrence of petroleum, natural gas and asphalt rock in western Kentucky, says in the "Kentucky Geological Survey," 1891:

> The statements now presented ..... bring before us two main views as to the origin of petroleum: First, petroleum is produced by the primary decomposition of organic matter, and mainly in the rocks that contain the organic matter. Second, petroleum results from the distillation of organic hydrocarbons contained in the rocks, and has generally been transferred to strata higher than those in which it was formed.

Discussing the age of petroleum deposits, Dr. Orton says: "Hunt believes petroleum to have been produced at the time that the rocks that contained it were formed, once for all." Newberry believes it to have been in process of formation solely and constantly since the strata were deposited. Peckham refers it to a definite but distant time in the past, but long subsequent to the formation of the petroliferous strata. He supposes it to have been stored in subterranean reservoirs from that time to the present.

Dr. David White, speaking of the rapid disintegration of animal matter, says:

> This forcibly suggests that the algæ which almost certainly have exerted an attraction for certain bitumens of extraneous origin, may have played the important rôle, first of storing up some of the hydrocarbon products of the decaying animal matter, and later, under dynamic influences, of releasing a part at least of the stored as well as, presumably, of their own original content in the form of petrolic or gaseous hydrocarbon.

Dr. F. W. Clarke believes that this transformation took place after burial: "Whatever sediments are laid down, inclosing either animal or vegetable matter, where bitumen may be produced, the presence of water, preferably salt, the exclusion of air, and the existence of an impervious protecting stratum of clay seem to be essential conditions toward rendering the transformation possible.[1]"

Cunningham Craig says: "It seems probable—but here we enter into speculation—that it is the pressure that is the determining factor, as it is in so many chemical reactions. Given the vegetable matter from which petroleum can be formed, and inclosed in a well-sealed deposit, given the presence of a limited quantity of water and the necessary but by no means high temperature, as soon as the pressure reaches a certain point the action will begin.[2]"

Concluding a discussion of the many theories to account for the origin of petroleum, E. T. Dumple, in a paper before the Institute of Mining Engineers, February, 1914, states:

> While many, if not all, of the theories advanced as to the production of petroleum have in them some element of truth, and while we believe that under diverse conditions petroleum may be and is formed in many different ways, the theory outlined, which recognizes the formation of petroleum under suitable paludal, bog or marine conditions at ordinary temperatures, by natural processes, the transformation being accomplished by the organic matter still retained essentially in its original character, and its deposition as petroleum with other sediments of its day seems well supported by observational facts, and its very simplicity and general applicability appear to offer strong grounds for the belief that it will sooner or later come to be recognized as one of the principal methods of the formation and accumulation of petroleum.
>
> In such a case all indigenous or primary deposits of petroleum will be of the same age as the sediments in which they occur and those of secondary or migrating oil would be of a different age than the inclosing beds.

Crude oil is petroleum that is in its crude state.

Fuel oil, as now delivered, is petroleum from which the gasoline and other highly volatile constituents have been driven off by distillation.

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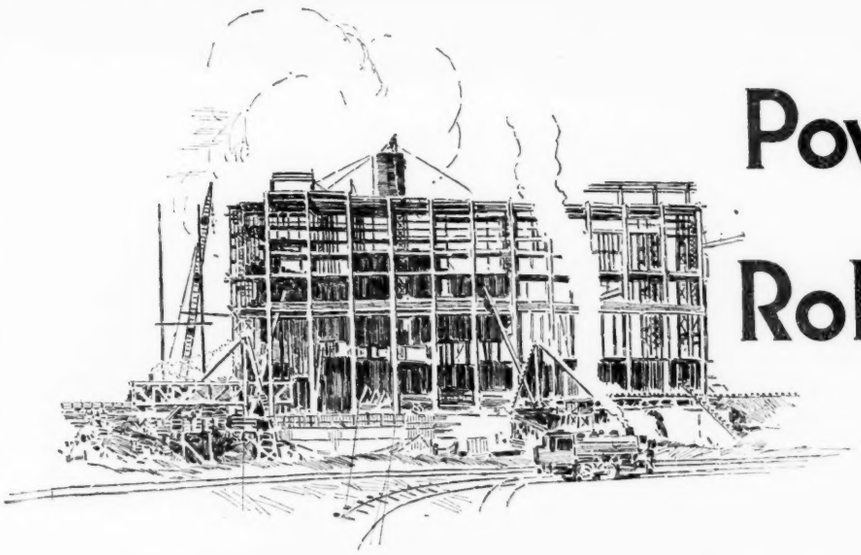
[1]Data of Geochemistry, p. 703, 1911.
[2]Oil Finding, p. 28.



Power Drives for Rolling Mills

By W. O. Rogers

A new boiler plant equipped with the latest apparatus and planned to be the last word in steel-mill boiler installation. The ash- and coal-handling equipment is of especial interest. Stokers are motor-driven and forced- and induced-draft fans are turbine-driven through a reduction gear.

AN EXAMPLE of the modern boiler plant for steel mills was found during my stay around Youngstown. This was at the Republic Iron and Steel Co.'s works, where they were building a new boiler plant in which was incorporated the best ideas and equipment that the engineers of the company could devise and procure. The reason for building this new boiler plant was because a greater steam volume was required than the existing plants were capable of producing and because it was necessary to change from gas to coal at intervals, the gas supply from the blast furnaces being insufficient to supply the fuel necessary to generate sufficient steam to operate the steam unit. As a large number of small boilers cannot be operated as economically as a battery of large units, it was decided to install modern high-pressure boilers equipped with front-feed underfeed stokers, superheaters and economizers, the boilers to be operated at from 100 to 200 per cent above rating.

he new boiler house is situated at a distance of 250 ft. from the turbine house, to which the steam will be piped. The building is of brick, with one end shut in with a false wall of corrugated iron, thus providing for future extension.

At present there are four 1,130-hp. water-tube boilers having four steam drums each 42 in. in diameter and 22 ft. 4 in. long. The drums are made with three $\frac{17}{32}$-in. sheets with triple-riveted butt-strap joints. The circular seams are lap-joint, double-riveted. The 4-in. tubes are arranged 36 wide and 14 high, and are 20 ft. long, giving a total of 11,296 sq.ft. of heating surface. The tubes are arranged in two banks. The lower bank is two tubes high with a space between the top row and the bottom row of the 12-high top section equal to that occupied by two rows of tubes. On top of the lower bank of tubes a horizontal baffle is used, running from a short distance in front of the vertical baffle of the first pass to the rear header. This gives both vertical and horizontal baffling to the boiler. The arrangement described is shown in the sectional view, Fig. 1. All pressure parts are made of openhearth steel at from 52,000 to 58,000 lb. tensile strength. The main steam outlet is 10 in. in diameter, and the boilers are designed for 225 lb. pressure with 125 deg. of superheat. Each weighs 785,000 lb., or 392.5 tons, and has a width of 24 ft. 10 in. and a height of 24 ft. 8¾ in. from the foundation to the steam outlet. Each boiler is equipped with a double U-bend superheater made up of four headers. The tubes are 71 wide, and arranged four deep with two high U-shaped tubes connecting with each header. Steam from the boiler steam drums enters the top superheater header and, passing through its respective tubes, enters the boiler header which is connected by nipples with the lower center header. From this header the steam passes through its respective tubes to the upper center header and then goes to the steam main.

In designing the furnace, attention has been given to the problem of obtaining proper combustion of the fuel burned. The furnace is built 12 ft. high and the width of the boiler. There are four 12-retort underfeed stokers, each 21 ft. 3 in. wide, with a length of 10 ft. 10 in., and 22 tuyeres high. The windbox under each stoker is sectionalized, so that by the operation of three dampers if any one of four plungers gets out of order the air can be cut out from that zone and the remainder of the stokers used until repairs can be made, thus preventing the boiler as a whole from being put out of service. Each stoker is equipped with four power boxes, thus sectionalizing the stoker into four sections of three retorts each.

Bituminous run-of-mine coal is to be used, and the stokers are designed to burn sufficient coal of not less than 12,000 B.t.u. to deliver 215 per cent of normal boiler rating continuously and to deliver, with coal of the same B.t.u., 300 per cent of normal rating for a duration of four hours.

The following are data of the stoker performance:

Percentage of Rating	Boiler and Furnace Efficiency	Flue Gas CO_2 Not More Than Per Cent	Air Required per Stoker at the Stoke Cu. Ft. per Min.	Second Pass
125	75	13.5	17,400	2.0
150	75	13.5	21,000	2.5
175	74	13.5	25,000	3.0
200	71	13.5	29,200	3.5
225	69	13.5	34,000	4.0
250	67.5	13.5	38,600	4.6
300	....	....	50,000	6.0

The stokers are driven by means of four 20-hp. motors, one for each unit, and having a variable speed of

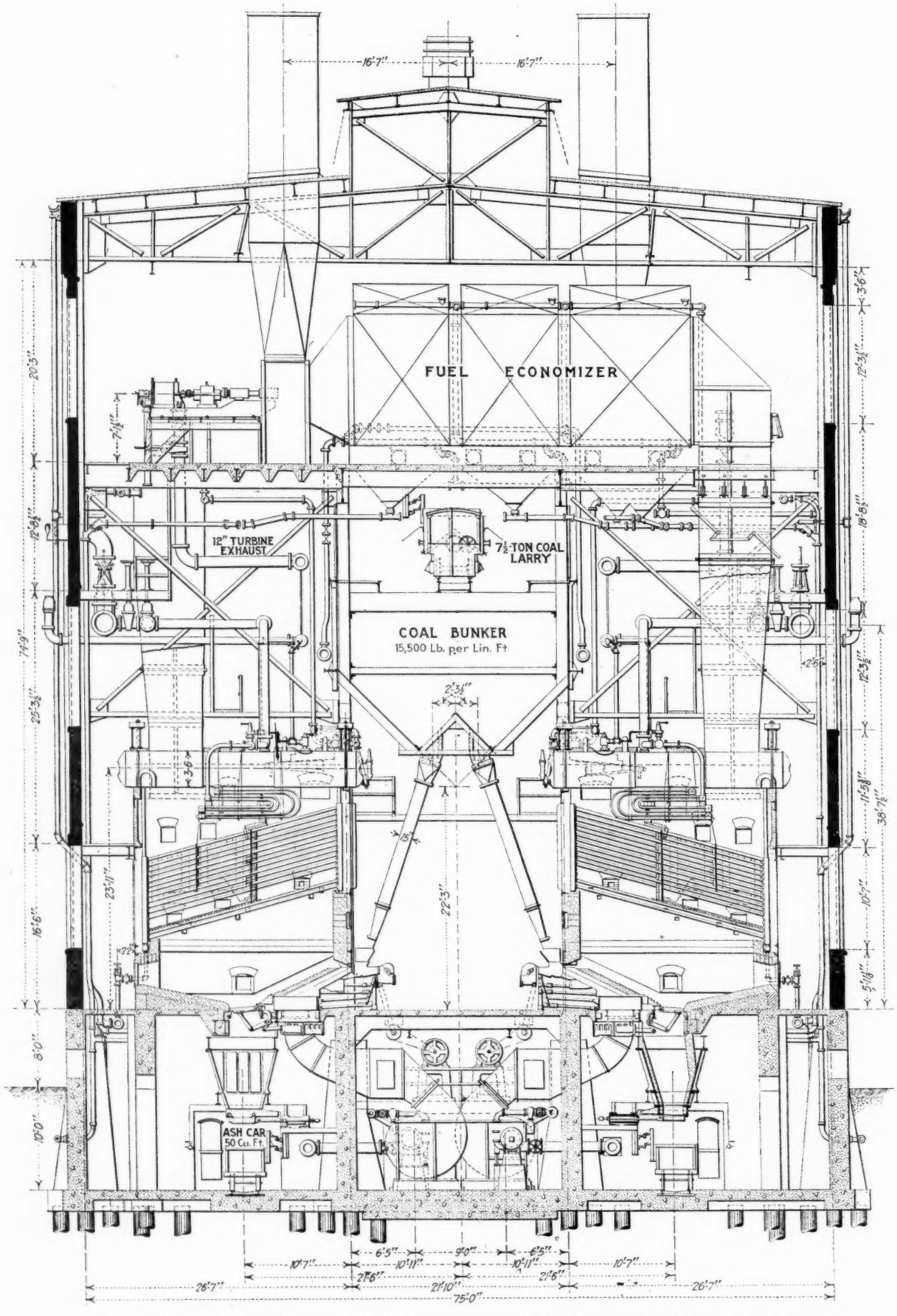


FIG. 1. SIDE ELEVATION OF THE NEW BOILER PLANT AT THE REPUBLIC STEEL AND IRON CO.

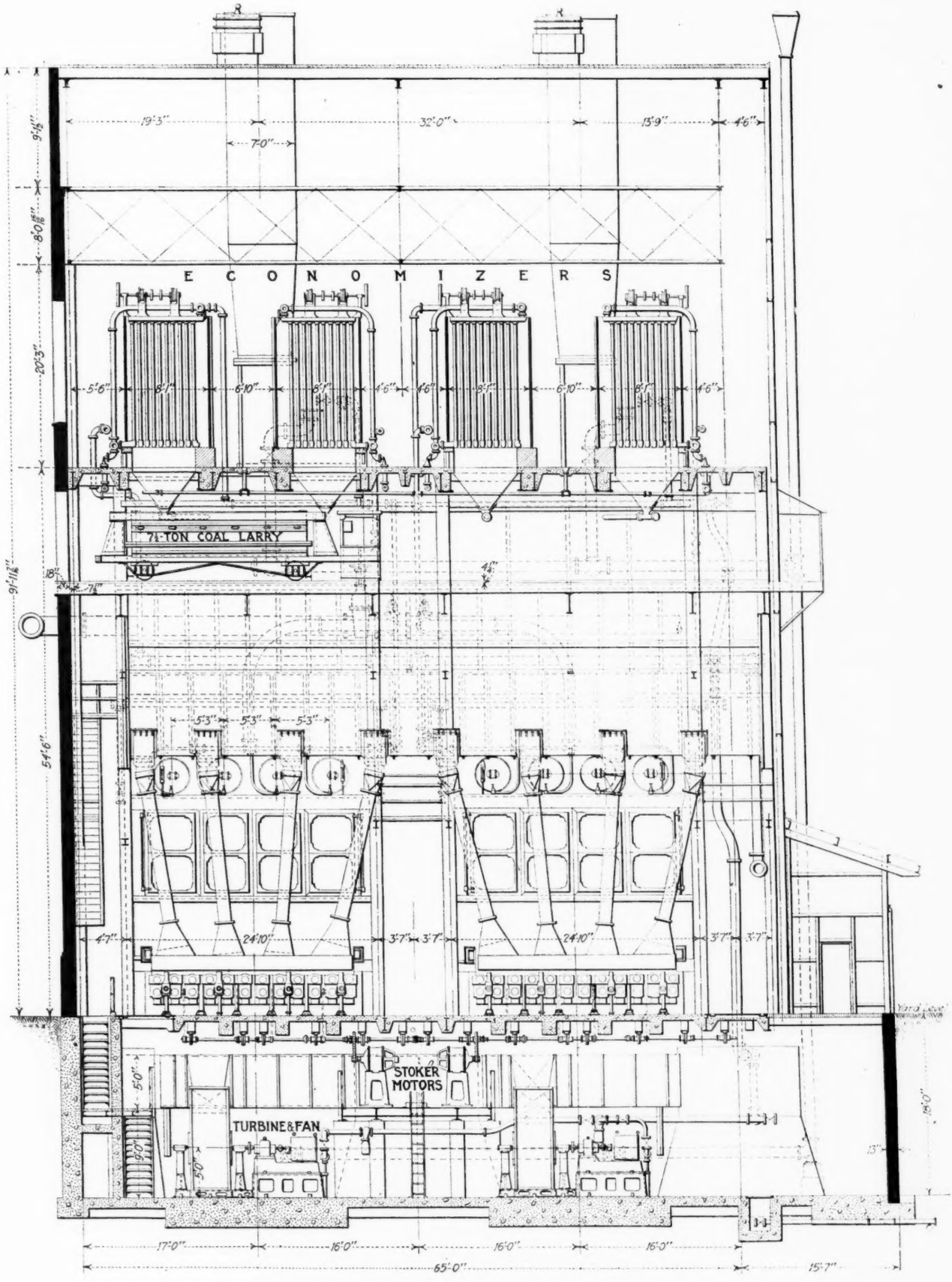


FIG. 1. FRONT ELEVATION OF THE NEW BOILER PLANT AT THE REPUBLIC STEEL AND IRON CO.

from 300 to 1,200 r.p.m., thus giving a stoker speed for any capacity from minimum to maximum. A single silent-chain drive is used between the motors and the driving shaft, but four chain drives are used with each stoker, there being a clutch for each four sections into which the stoker drive is divided.

All four motors are mounted in the basement on a platform built on I-beams inserted at the ends of the

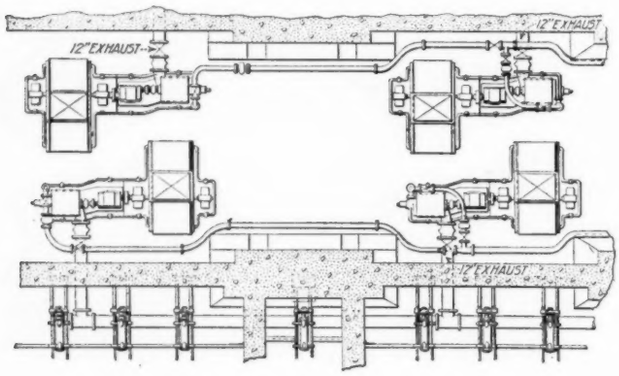


FIG. 3. PLAN OF FORCED-DRAFT LAYOUT

concrete tiers that support the front portions of the boiler (see Fig. 2). This gives a headroom below the motor of 8 ft. 10 in. The stoker driving shaft is also placed in the basement, being suspended in suitable bearings hung from the boiler-room floor.

As the stoker motors are located below the operating aisle between the boilers, two of which are on each side and mid-distance of the length of the boiler room, ample space is provided for the four turbine-driven forced-draft fans, which are also placed in the basement. Each turbine is of 130 b.hp. capacity and drives its connected fan through the medium of a reducing gear, the pinion having a speed of 3,510 r.p.m., and the fan 1,350 r.p.m. Each turbine is designed with eight stages to operate either condensing or noncondensing with 225 lb. steam pressure and 200 deg. superheat. A direct-driven governor controls the speed, and an emergency governor which will automatically close its governor valve when a predetermined speed limit has been passed.

The turbines are designed to operate either condensing or noncondensing. When operating condensing extra nozzle holes are plugged, but if the turbine is to operate continuously noncondensing, the plugs are removed. At least 10 per cent better economy will be obtained running condensing than operating noncondensing with the bypass valve open. Each turbine will develop full or partial load without the use of the bypass or overload valve and will also develop one-half greater overload without the use of the bypass, but with the overload valve open.

These turbines are designed to carry their load at their respective speeds with any steam pressure as low as 70 lb. gage, running noncondensing. With both bypass and overload valves closed, the turbines will carry their normal rated load and speed when operating condensing. With the overload valve open and the bypass valve closed, they will carry 25 per cent overload condensing, and with the bypass valve open and the overload valve closed each machine will carry its normal rated load and speed when operating noncondensing. With both bypass and overload valves open the turbines will carry 25 per cent overload operating noncondensing.

The following are the guarantees for condensing operation load or normal full load of 130 b.hp., and with a turbine speed of 3,510 revolutions per minute:

Load Per Cent	Horsepower	Steam Consumption per Horsepower-Hour Condensing	Noncondensing
125	162.5	21.3	45.6
100	130.0	20.5	43.4
75	97.5	21.6	47.5
50	65.0	24.3	51.5

The following horsepower guarantees are made with the speeds given:

Hp.	Turbine r.p.m.	Gear r.p.m.	Pounds Steam Condensing	Noncondensing
130.0	3,510	1,330	20.5	43.7
70.2	2,940	1,130	24.5	50.8
36.1	2,275	875	35.7	77.0
21.7	1,935	740	47.6	104.5

Each turbine is connected to its individual fan by a double-helical reduction gear and a flexible coupling, the latter being placed between the reduction gear and the fan. All four forced-draft fans are of the double side-inlet type. The full housing is horizontally split along the center line of the shaft, which permits of removing the rotating element without breaking the flue connection. The discharge outlet is at an angle of 45 deg. and connects to the air duct with easy bends, which reduce the resistance of the air in passing through

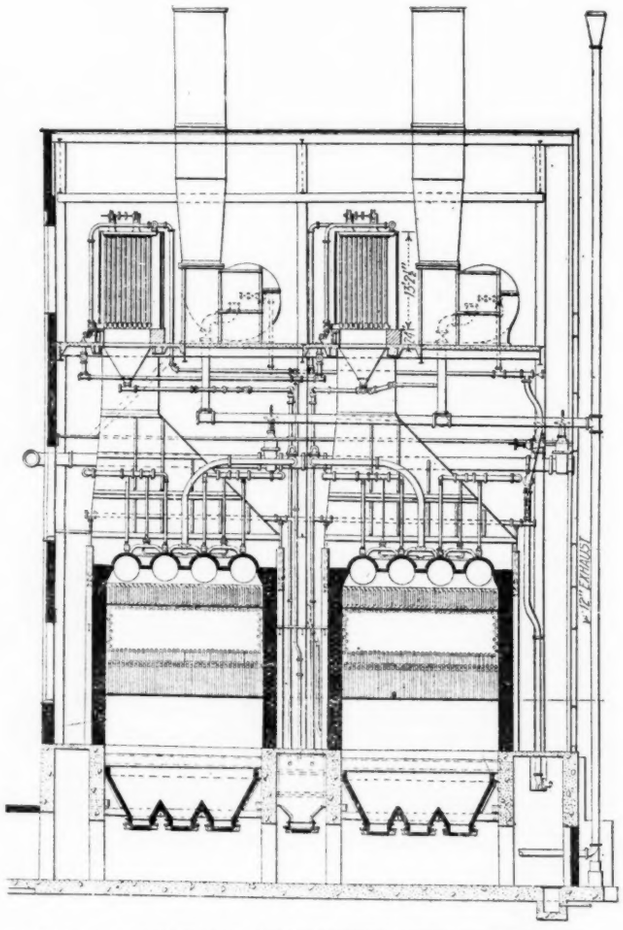


FIG. 4. SHOWING ECONOMIZER CONNECTION TO SMOKE FLUE

the connection. Two fans are connected to each of the two ducts, which extend below the boiler-room floor for the length of the boiler setting, one on each side of the operating aisle. Each air duct is divided in the center by a damper, so that either boiler can use either fan, or in case of emergency one fan can take care of both boiler furnaces under certain rating. Each air

duct is 5 ft. high and 3 ft. 3 in. wide, inside dimensions. The four outlets to the windboxes of each stoker connect the main air duct with easy curves. In the discharge of each fan is mounted a louvre type of damper connected through the fan housing with a common lever for hand operation. The approximate rate of each forced-draft fan is 5,200 lb.; that of the induced-draft fan is 8,140 lb. Fig. 3 is a plan view of the forced-draft fan layout.

The capacity of each forced-draft fan at 1,350 r.p.m. is 60,000 cu.ft with air at 70 deg. F., and the capacity of the induction-draft fan at 690 r.p.m. is 97,000 cu.ft. per min., the static pressure being 6 in. of water. The draft loss is figured as follows: Draft loss through the boilers, 2 in.; loss through the economizers, 2.65 in.;

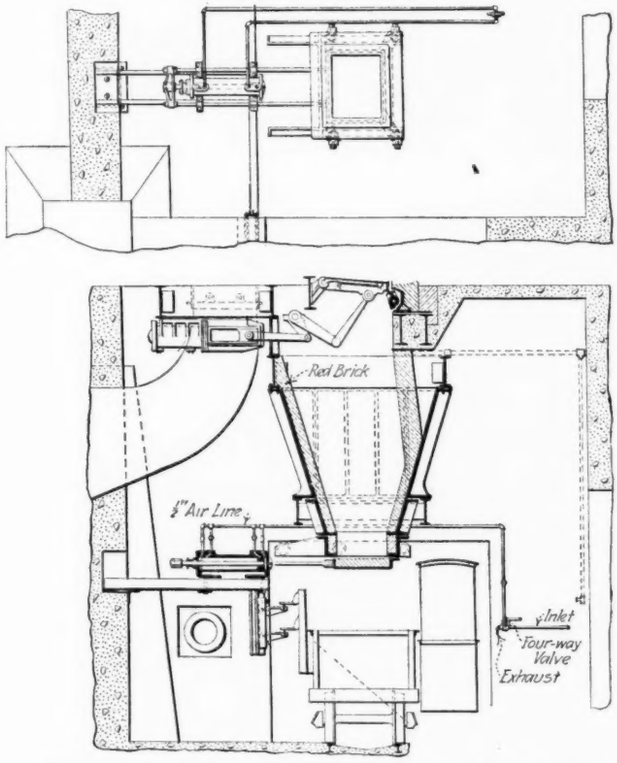


FIG. 5. DETAILS OF ASH HOPPER AND ASH GATES

through flues, 0.25 in.; total draft loss through boiler, 4.9 in.

Above the boilers is a floor on which the four economizers and the four turbine-driven induced-draft fans are placed, Fig. 4. Each fan discharges into a venturi stack, 7 ft. in diameter at the top and tapering to 5 ft. 4 in. at the bottom, the taper extending for a distance of 11 ft. The top of each stack is 34 ft. above the outlet connection of the fans.

Nothing could be more directly connected and compact than the arrangement of the economizers and the induced-draft fan. The flue connection from each boiler to its economizer is vertical and is of the venturi design, being 7 ft. in diameter at the top and 6 ft. 4 in. at the boiler end. Each economizer contains 520 pipes arranged in 52 sections, 10 pipes wide, approximately 12 ft. long, and having a total heating surface of 18,500 square feet.

Cross-circulation is used. The pipes are arranged so that each economizer is divided into three groups. Water enters the bottom cross-pipe in the first group, and the hot gases enter at the opposite end of the economizer, thus adopting the counterflow principle. From the bottom header the water flows upward through the tube of that section, and into the top headers, and then into the top cross-pipe which connects with a bottom cross-pipe of the second group; then, as before, to the top cross-pipe of the second group, and by a cross overpipe to the bottom cross-pipe of the third group. The water is delivered from the top cross-pipe to the third group of pipes at its maximum temperature, and is then fed to the boilers. With a gas-inlet temperature of 615 deg. F. and a gas-outlet temperature of 397 deg., the water, with an inlet temperature to the economizer of 190 deg., will have an approximate outlet temperature of 300 deg. The approximate weight of each economizer is 240,000 lb., or 120 tons.

Each economizer is fitted with three 2½-in. combination blowoff valves and three release valves, one of each for each section. They are inclosed with sectional russia iron, lined with 2-in. asbestos, each section being easily removable for inspection. The scraper drive for each unit is a 13-hp. motor.

Ashes from the stokers of the boilers are deposited in an individual three-outlet iron ash hopper, lined with red brick. Each is constructed so that the sections which are bolted together are 21 ft. 3 in. long and 6 ft. 8¾ in. wide at the top and 2 ft. wide at the bottom, the outlets being 2 x 3 ft. Pneumatic operated gates, details of which are given in Fig. 5, are fitted to the outlet of the ash hopper, the gate being operated on rollers and actuated by a plunger controlled by a four-way valve. The ashes are dumped into motor-operated cars having a capacity of 50 cu.ft. and run on a 2-ft. 6-in. gage track. The loaded car is run to a hopper, from which the ashes are elevated to the top of the hoist and automatically dumped into a chute leading to a bin, from which they are loaded into railroad cars for removal.

The operation of the ash hoists is of interest. When the ash handler desires to elevate a load of ashes that has been dumped into the hopper, he presses a starting switch to start the 50-in. d.c. motor. When the 70-cu.ft. capacity skip nears the top, a resistance coil is cut in on the circuit, which causes the motor to slow down. When the ash bucket reaches the dumping position, the circuit is automatically cut and the bucket stops long enough to discharge its contents. By means of a relay switch on the control board, after the bucket has remained at the dumping position a sufficient length of time to dump, the current is automatically applied to the motor, which has been reversed by means of a limit switch, and the bucket is sent to its original loading position ready to receive another load. The cycle comprises a period of 2½ minutes.

Coal is delivered from bottom-hopper railroad cars into a rack hopper having a top measurement of 13 x 36 ft., or 468 sq.ft. area. From this hopper the coal is conveyed to the crusher by means of a 65-ft. long center to center, apron type conveyor, with a width of 36 in. It has a capacity of 180 tons per hour at a speed of 40 feet per minute. Power to operate this conveyor is taken from the crusher-shaft transmission by means of a chain drive to the hoist countershaft of the conveyor drive. The crusher is of the four-roll type, each roll being 36 in. in diameter and 36 in. face. One pair of rolls is held rigidly in position, but the other pair is provided with heavy coil springs which exert enough tension on the rolls to press the coal, and yet permit of giving in case a foreign substance is encountered. The rolls and apron conveyor are operated by a 100-hp. compound-wound motor at 850 r.p.m. The capacity of the crusher with run-of-mine bituminous coal crushing to 90 per cent ¾-in. size, is 180 tons per hour.

Both the crusher and apron conveyor are located out-

side of the boiler house, as is also the double skip hoist that elevates the coal from a bifurcated hopper after it has passed through the crusher. Each skip bucket has a capacity of 120 cu.ft. The 42-in. double-drum hoist is operated by a 60-hp. compound-wound motor. The grooves in the hoist drum are for a ⅞-in. cable. When the skip descends, a lever on the front of the bucket engages the gate of the chute leading from the crusher hopper, thus opening the gate, which is held open by means of a latch. The skip bucket then comes to rest on a counterweight lever of the skip. When sufficient coal has been discharged into the skip, the counterweight lever is depressed, the latch holding the gate open is released, and the gate closes to shut off the flow of coal. When the lever is thus operated, a switch is thrown which starts the motor operating the hoist, and the bucket is hoisted until it reaches a predetermined point, when resistance is cut in the circuit. When the bucket reaches the dumping position, current is cut off from the motor, and the bucket stops.

A 7½-ton motor-operated distributing larry car carries coal from the skip-hoist hopper, located at the head of the hoist, and discharges from both sides simultaneously into a coal bunker placed central over the boiler-room operating aisle. This bunker has a capacity of 15,500 lb. per lin. ft., and as it is 64 ft. in length, the capacity is approximately 500 tons. From the overhead bunker the coal is fed through four 15-in. spouts to the stoker hopper.

Dalton's Law Applied to Air-Pump Capacities

By Frank R. Wheeler

The presence of air in a condenser has two very detrimental effects. It increases the total absolute pressure or reduces the vacuum dependent upon the amount present and, in a surface condenser, reduces the heat transfer. Josse[1] reported a relative coefficient of heat transfer, as referred to steam of one to seven hundred.

Although the air that enters the condenser with the boiler-feed water and through leaks in the system has a moisture content dependent upon its humidity and temperature, for practical reasons it is usual to consider the leakage as dry air. This air admitted to the condenser is heated to the temperature corresponding to the vacuum, and through contact with the steam becomes saturated. The air pump must, therefore, remove with the noncondensable gases, or air, an amount of water vapor, or steam, dependent upon the temperature and pressure of the mixture at the air-pump suction.

By Dalton's Law the total pressure of a mixture of gases is the sum of the partial pressures of the gases present. For example: A condenser maintaining a vacuum of 2 in. absolute (28 in. referred to a 30-in. barometer) with condensate at 90 deg. F. indicates that the steam present has, from the steam tables, a partial pressure of 1.417 in. absolute and the partial air pressure then is 2 — 1.417, or 0.583 in. absolute.

A mixture of steam and air, unlike a pure saturated mixture, may change in temperature without effecting a change in the total pressure of the mixture, the change in temperature depending upon the relative partial pressures of the steam and air.

Assume a mixture of steam and air at a temperature T deg. F. and a total pressure P lb. per sq.in. absolute made up of 1 lb. of steam at temperature T deg. F. and corresponding pressure P_s and occupying V cu.ft., and a quantity of air also at temperature T deg. F. and occupying V cu.ft., but at a partial pressure P_a.

One pound of dry air at 32 deg. F. and a barometric pressure of 29.92 in. of mercury, or 14.6963 lb. per sq.in. absolute, occupies 12.387 cu.ft. and at temperature T deg. F. and pressure P_a in. of mercury occupies:

$$\frac{29.92}{P_a}\times\frac{T+459.6}{32+459.6}\times 12.387 \text{ or } \frac{(T+459.6)\times 0.75452}{P_a} \text{ cu.ft.}$$

V cu.ft. of the air weighs $\frac{P_a\times V}{(T+459.6)\times 0.75452}$ lb., and since this is the weight of air mixed with one pound of steam, the weight of steam per pound of air is

$$\frac{1}{\frac{P_a\times V}{(T+459.6)\times 0.7542}} \quad \text{or} \quad \frac{(T+459.6)\times 0.75452}{V\times P_a}$$

where V = specific volume per pound of steam at temperature T deg. F.; P = total pressure in condenser, inches Hg. absolute; T = the temperature of the mixture in degrees F.; P_s = partial steam pressure corresponding to the temperature of the water present, in inches of mercury absolute; and P_a = partial air pressure in inches of mercury absolute (P-P_s).

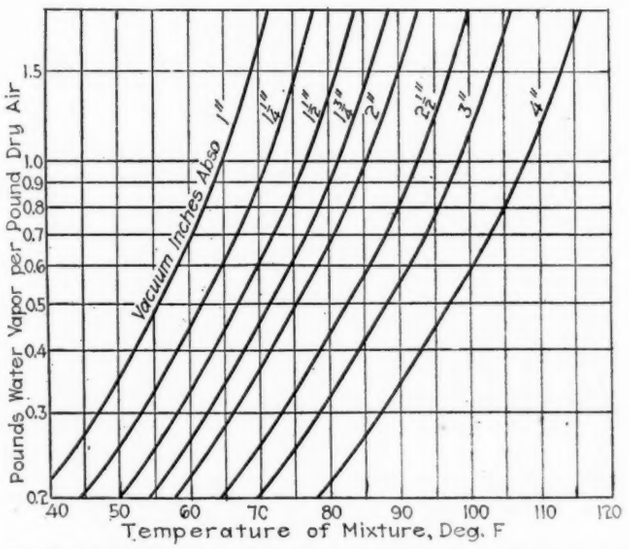


CHART SHOWING ADDITIONAL CAPACITY THAT MUST BE PROVIDED IN AN AIR PUMP TO REMOVE ASSUMED LEAKAGE OF DRY AIR INTO THE CONDENSING SYSTEM

From this formula the accompanying chart has been plotted to show the additional capacity that must be provided in an air pump to remove the assumed leakage of dry air into the condensing system.

For example: Assume a turbine installation where provision is to be made for an air leakage of 20 lb. of dry air per hour (approximately 4.45 cu.ft. per min.) through joints and from air entrained in the boiler-feed water. This condenser is to maintain a vacuum of 28 in. referred to a 30-in. barometer, or 2 in. absolute, with circulating water entering at 70 deg. F. and leaving at 88 deg. F. With good design the mixture at the air-pump suction can be assumed as a mean of these, or 79 deg. F.

From the chart it will be found that to remove one pound of air under these conditions it is necessary also to remove 0.6156 lb. vapor, so that the total air-pump capacity required is 1.6156 × 20, or 32.3 lb. of mixture per hour (approximately 7.18 cu.ft. per min.) in order to remove 20 lb. of dry air per hour.

[1] *Engineering*, London, Vol. 85, 1908.

Sampling Tanks Versus Continuous Recorders for Determining CO_2

By CHARLES C. PHELPS

A discussion of the correctness of results of CO_2 determinations by different methods. Explains some of the common errors and suggests proper method of procedure.

ENGINEERS and firemen who are striving to operate their power plants efficiently, try to maintain a high percentage of carbon dioxide (CO_2) in the flue gases from their boiler furnaces. Hence, frequent measurement of CO_2 becomes necessary. Three methods of taking these measurements are in common use, namely: By withdrawing samples of gas directly from the flue at regular intervals and making analyses with an Orsat or other hand analyzing apparatus; by collecting the gas in a sampling tank during a period of definite duration, for instance, a shift or a 24-hour run, and later analyzing the contents of the tank for the average percentage of CO_2 during the period covered; and by automatically recording the percentage of CO_2 continuously on the chart of a CO_2 recording instrument which is permanently connected with the flue.

The last-named method has many important advantages over the other two. It shows stack conditions at once, instead of some minutes or hours later, hence it is easier to correlate the CO_2 with such factors as change of draft, addition of coal and varying demand for steam, and to arrive at logical conclusions as to causes of inefficiency, while such knowledge can be used to improve the efficiency. Furthermore, it gives a continuous permanent record from which the heat losses up the chimney may be determined for any instant or for a total elapsed time. So-called snap tests made by hand analyzing apparatus give the data for determining chimney losses at only a given instant, but it is unlikely that such data would represent true average conditions. The CO_2 sampling tank, on the other hand, does not supply a means of determining CO_2 percentage at any given instant, but furnishes a sample from which it is assumed that the average heat lost up the chimney may be calculated. This last assumption, however, is not warranted by the facts.

Sampling Tanks Take No Account of Rate of Driving

Gas flows into the sampling tank at a uniform rate; that is, a constant volume is collected during each unit of time. One thousand cubic inches, say, of gas are withdrawn from the flue every hour irrespective of the total amount of gases passing up the chimney during each hour, the rate of flow up the chimney, of course, varying with the rate of driving the fire. Supposing the coal records show that five times as much coal is consumed during the second hour as during the first and a record from a continuous CO_2 chart shows a uniform CO_2 percentage for the two hours; we would then know from the coal and CO_2 records that the total loss was five times as serious during the second hour, although the percentage of CO_2 did not change. Analysis of the tank sample, on the other hand, would not give much enlightenment, for we would not know whether CO_2 was high during the first hour and low during the second (which would make the losses worse than they might appear to be) or whether low CO_2 occurred during the first hour and high during the second (which would mean better economy than the analysis would appear to indicate). It is apparent that the use of the sampling

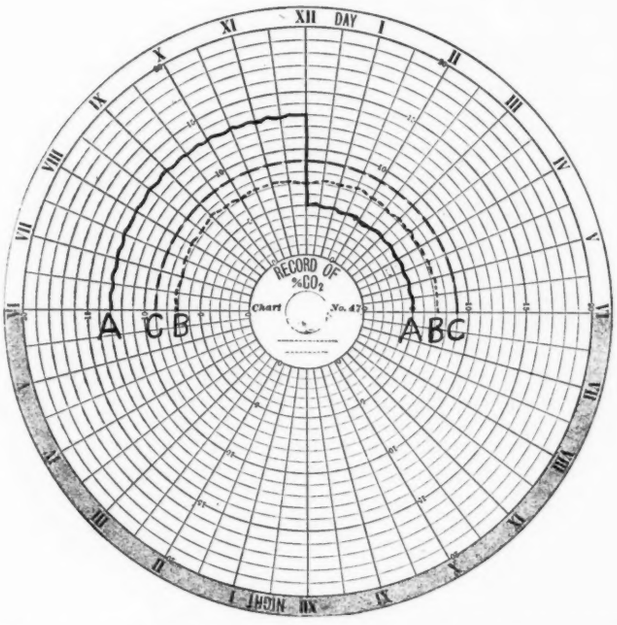


FIG. 1. CHART SHOWING AVERAGE CO_2 IS NOT GOOD INDICATION OF HEAT LOSS

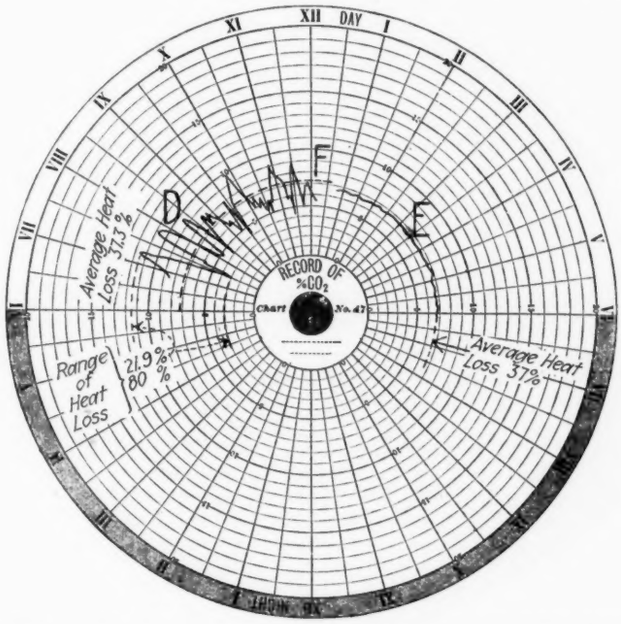


FIG. 2. CO_2 CHART SHOWING AVERAGE HEAT LOSS FOR VARYING CO_2

tank is likely to lead to serious errors in both directions, for the simple reason that it withdraws its sample at a uniform rate, whereas the flow of gases up the flue is constantly fluctuating. Another point is that the greatest opportunities for fuel saving occur while the furnace is being forced, and that a special effort should be made to keep CO_2 as high as possible at such times.

Why Average CO_2 Does Not Determine Average Heat Losses

In addition to the objection already pointed out, there is inherent in the sampling-tank method another fallacy which is perhaps even more serious. A definite relation exists between the percentage of CO_2 in the flue gases and the percentage of the total heat of the fuel that is wasted up the chimney. At a stack temperature 600 deg. F. above the temperature of the atmosphere this relation is approximately in accordance with the accompanying table. This table is based on the complete combustion of pure carbon as fuel. For fuel containing other constituents besides carbon, and for incomplete combustion, the ratios would of course vary somewhat. For stack temperatures other than that assumed in this case, the heat losses would be in proportion to the temperature; for instance, with a stack temperature 300 deg. above atmospheric the losses would be one-half as great as those noted in the table.

To illustrate the second fallacy involved in the sampling tank method, let us assume such a case as that represented by the CO_2 recorder chart shown in Fig. 1. Here the chart record shows by *A* that the percentage of CO_2 was kept steadily at 13 per cent. from 6 a. m. to noon and at 5 per cent. from then until 6 p. m. (an average of 9 per cent. CO_2 for the twelve hours). From the table the loss up the chimney corresponding to 13 per cent. CO_2 is found to be 19.3 per cent. and the loss corresponding to 5 per cent. CO_2 is 49 per cent. Hence, the true average loss up the chimney for the two six-hour periods is $\frac{19.3+49}{2}=34.2$ per cent. if the flue temperature and rate of driving remain constant. The same loss would have resulted if the CO_2 had been maintained steadily at 7¼ per cent. (*B*, Fig. 1) for the full twelve-hour period, inasmuch as 34.2 per cent. loss corresponds to 7¼ per cent. CO_2 (see table).

The sampling tank would have given a result entirely different from the foregoing. One-half of the flue-gas sample would have contained 13 per cent. CO_2 and the other half 5 per cent., making the average percentage of CO_2 as determined by analysis $\frac{13+5}{2}=9$ per cent. (*C*, Fig. 1). The loss corresponding to 9 per cent. CO_2 is 27.6 per cent. This false result would be certain to mislead an observer into believing that the chimney losses were $34.2-27.6=6.6$ per cent. lower than they really were. In other words, the error resulting from the use of the sampling tank in this case amounts to $\frac{6.6}{34.2}=19$ per cent. In actual practice the error might be much greater or less than this, depending entirely upon the conditions of operation.

From the foregoing it is quite apparent that it is more important to know the extent of the fluctuations in percentage of CO_2 than the average values. One of the advantages of snap tests made by hand analyzing apparatus over averaging tests based on tank samples is that if the snap tests are made with sufficient frequency they do give some idea of the extent of fluctuations and at least make it possible to determine the exact loss at the instant the sample was taken. The continuous autographic record is, on the other hand, preferable to either of the other methods inasmuch as it really is equivalent to an infinite number of readings and, hence, all fluctuations of CO_2.

From the "Loss Increment" column in the table it will be noticed that the heat lost up the chimney increases rapidly as the percentage of CO_2 in the flue gases becomes less. Hence, on such a record as that shown at *D*, Fig. 2, the losses represented by the parts of the record near the center of the chart are out of all proportion to the losses on parts of the record farther out radially. This illustrates clearly why a flat record is more desirable than a fluctuating one and shows why, when CO_2 is held constantly at one point, the chimney loss is bound to be less than when CO_2 fluctuates in

HOW CHIMNEY LOSSES VARY WITH CO_2 AT STACK TEMPERATURE 600 DEGREES F. ABOVE TEMPERATURE OF ATMOSPHERE. BASED ON CARBON AS FUEL

Per Cent. CO_2 in Flue Gas	Per Cent. Loss Up Chimney	Per Cent. Loss Increment	Per Cent. CO_2 in Flue Gas	Per Cent. Loss Up Chimney	Per Cent. Loss Increment
21	12.2		11	22.8	1.9
20	12.8	0.6	10	25.0	2.2
19	13.5	0.7	9	27.6	2.6
18	14.2	0.7	8	31.0	3.4
17	15.0	0.8	7	35.3	4.3
16	15.9	0.9	6	41.0	5.7
15	16.9	1.0	5	49.0	8.0
14	18.0	1.1	4	61.0	12.0
13	19.3	1.3	3	80.0	19.0
12	20.9	1.6			

amount but is of an equivalent *average* percentage. Conversely, a flat curve, as *E*, might actually mean better efficiency than a fluctuating curve *D*, which represents a greater average percentage of CO_2. In this case the flat record *E*, showing 6.7 per cent. CO_2, indicates 37 per cent. chimney loss, whereas the fluctuating curve *D* shows an average chimney-loss percentage of 37.3 per cent. (the latter calculated from readings at 7½-minute intervals on the chart). Curve *D* fluctuates between losses of 21.9 and 80 per cent. heat losses. Here the record *D*, which shows the greater average percentage of CO_2, namely, 7.2 per cent. (as actually determined by radial planimeter and represented on Fig. 2 by the dotted line *F*) paradoxically represents a greater loss than the record *E* with a smaller percentage of CO_2.

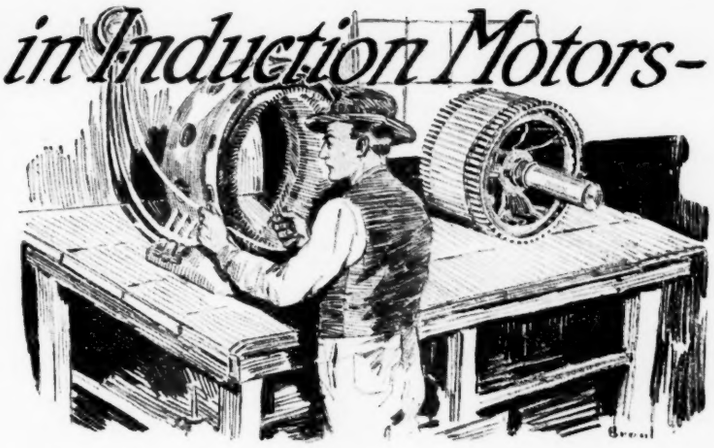
The cases cited in this article point to conclusions that should be followed in practice.

1. Strive to obtain the highest practicable percentage of CO_2 in the flue gas.
2. Keep the percentage of CO_2 as nearly uniform as possible. Uniformity is second in importance only to the *largeness* of percentage of CO_2.
3. The more nearly continuous the record of CO_2 the better, inasmuch as this enables the operator to determine the scale of fluctuation more accurately.
4. The average or total heat losses up the chimney cannot be calculated with accuracy from the average percentages of CO_2. The average percentage of heat loss is determined most accurately by finding the corresponding heat losses for as many points on the CO_2 record as possible and then averaging these figures.
5. In determining chimney heat losses for a "heat balance" or as a check on regular operation, keep in mind that the varying rate of combustion is of as great importance as the percentage of CO_2 in the flue gas.
6. The cost of installing and operating a continuous autographic CO_2 recorder is small in comparison with the possible savings in fuel in the average power plant. The United States Fuel Administration recommended the use of CO_2 equipment for any plant burning five tons of coal or more per day; in many plants where the fuel consumption is much less, the operation of such equipment pays handsome returns on the investment. In very small plants it will surely pay to use a hand analyzer, which, though possessing many shortcomings, is nevertheless a very valuable instrument.

Locating Faults in Induction Motors—

Noise *and* Vibration

By
A. M. Dudley *



The First of Three Articles on Locating Faults in Induction-Motors. The Observations of the Behavior of the Motor To Be Made When Started for the First Time, and How To Distinguish Between Mechanical and Electrical Troubles.

AFTER the coils have been placed in a motor and the cross-connection completed according to the desired diagram, a check is necessary to insure that the connections are properly made before load is put on. The simplest way of making this check is to start up the motor and run it light on a circuit of the proper phase, frequency and voltage. Observation of the behavior of the motor under these conditions indicates to the trained observer whether there are any serious discrepancies in the winding or connections. This observation should cover five points; namely, speed, noise, mechanical vibration, general heating of the whole winding and local heating of one or more separate coils.

The speed, if correct, should be of nearly synchronous value when the motor is running without load; that is, equal to cycles times 120 divided by the number of poles.

The motor should give a low humming noise similar to that made by transformers, but there should be no irregular or "growling" noise. There may also be a considerable volume of air noise or whistle caused by the ventilating air passing through the air ducts in the rotor and stator. The magnetic noise may be distinguished from the air noise by the expedient of opening the switch for a second or two while the motor is running full speed without load. Opening the switch breaks the current and removes the magnetic field, and consequently the magnetic noise ceases, but leaves the rotor running at practically the same speed owing to its inertia or stored energy, and hence the windage, or air noise, is practically unaffected. In this way, by opening and closing the switch two or three times, it becomes readily apparent what part of the total sound made by the motor is magnetic and what part is windage. It also indicates whether either or both of these sounds are abnormal. If the speed is correct and the motor makes no more than a reasonable singing or humming noise, the hand should be placed on the frame to note the mechanical vibration.

If there is noticeable mechanical vibration, it may be due to purely mechanical causes or to magnetic causes or possibly to both. By opening and closing the switch, as described in the foregoing, the mechanical vibration due to the magnetic field can be easily separated from that due to strictly mechanical causes, because when the switch is open there is no magnetic field present. Suppose, for example, that when the motor is running at full speed there is a marked vibration or trembling that can be felt when the hand is laid on the frame of the motor. Suppose, then, that when the switch is opened for a second or two the vibration disappears and the motor rotates smoothly at nearly the same rate of speed. This, then, is evidence that the vibration was caused by the action of the magnetic field on the stator and rotor. However, if the motor vibrates whether the switch is open or closed, it is evidence that the action is purely mechanical and is affected little or not at all by the presence of the magnetic field.

When the trouble is traceable to the magnetic field, it may indicate improper connection of the winding or it may indicate that the mechanical clearance between stator and rotor is not symmetrical or that there is some similar combination of mechanical and magnetic features that is responsible for the vibration noticeable. The commonest mechanical causes for vibration are rotor out of balance, either standing or running; bent shaft; too great clearance between shaft and bearings; unbalanced or eccentric coupling or pulley or a combination of two or more of these faults. These mechanical conditions are easily determined and can be corrected. The commonest causes of mechanical vibration due to a combination of mechanical and magnetic conditions are rotor out of round, stator out of round, too great clearance in the bearings, or rarely, uneven or eccentric air gap or clearance between stator and rotor. The latter point seldom gives trouble and a polyphase motor will practically always run without giving any trouble until the bearing wear allows the rotor to strike on the stator. Single-phase motors are more sensitive to eccentricities in the air gap or clearance between stator and rotor and sometimes show a considerable variation in torque in motors otherwise duplicate due to such irregularities.

There are a number of elements that may cause the rotor or stator to be out of round. In the first place there is a slight variation due to the punch-and-die work, which may amount to 0.005 in. between individual punchings. In the second place some allowance around the outside of the punching must be made in the fixture or frame in which they are built up so that they will assemble readily, and this allows the punchings to stagger more or less. In the third place when the punchings are actually assembled in the frame, the frame may spring out of shape slightly after machining, owing to the release of casting strains when removing the material in the cut. Of course none of these variations is in itself large, but when they all accumulate in the same direction, perceptible eccentricity may result amounting to a good many thousandths of an inch. This is not serious, since it is present to some extent in all motors, but under extreme or extraordinary conditions it may cause mechanical vibration.

*Designing engineer, Westinghouse Electric and Manufacturing Co.

Mechanical vibration caused by the windings may be due to either the rotor or the stator. For example, in a squirrel-cage rotor there may be bad contacts between certain bars and the short-circuiting rings, resulting in more resistance in some parts of the winding than in others. This in turn affects the distribution of current in the different bars and hence affects the magnetic field and varies the mechanical pull from point to point. Or if the winding on the rotor of a wound-rotor type motor is ground in a number of places, it will also cause unequal distribution of the current in the windings, which in turn causes severe vibration during the starting period. However, this generally disappears to a large extent after the motor comes up to full speed. From this it may be seen that where mechanical vibration is absent the conclusion may be drawn that the windings are symmetrical and are functioning properly, but where vibration is present it may be caused by a number of things, some of them obscure, and must not immediately be attributed to improper winding connections until a further examination is made.

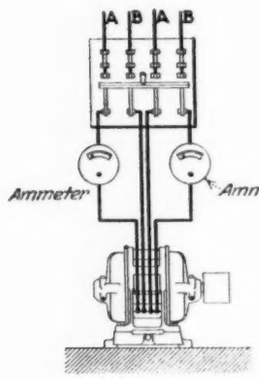


FIG. 1. AMMETER CONNECTIONS FOR FOUR-WIRE TWO-PHASE MOTOR

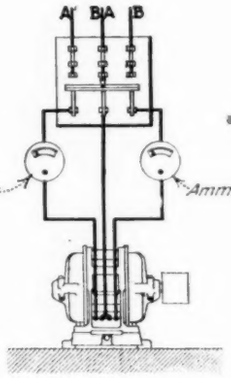


FIG. 2. AMMETER CONNECTIONS FOR THREE-WIRE TWO-PHASE MOTOR

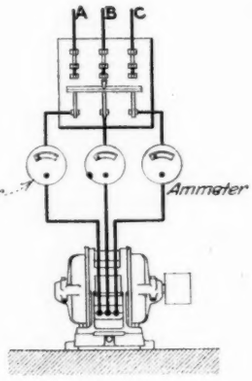


FIG. 3. AMMETER CONNECTIONS FOR THREE-PHASE MOTOR

The next point to be observed is the general temperature of the entire winding as determined by passing the hand around the ends of the windings. It is best practice in making this examination to shut down the motor after it has run three to five minutes. If the examination is made while the motor is running, care should be taken to avoid injury by coming in contact with moving parts and also to avoid injury from electric shock, if the circuit is 550 volts or over. If the winding as a whole is cool, inspection should be made for individual coils that are much hotter than the rest of the winding, as these may indicate short-circuits or improper connections in that particular coil.

If a motor is operating freely and easily at the proper speed without undue noise or mechanical vibration and if there is no general or local heating of the winding, the next step is to measure the current in each phase. This may be done as indicated in Figs. 1, 2 and 3. If possible an ammeter should be connected in each phase so that the readings of all phases may be taken simultaneously. For a two-phase motor two ammeters are required, as in Figs. 1 and 2, and for a three-phase motor three ammeters are required, as in Fig. 3. The no-load, or magnetizing current as it is called, will usually be somewhere between 15 and 35 per cent of the full-load current with an average value of perhaps 25 per cent. If the no-load current in all phases is equal and approximately 25 per cent of the full load, it is safe to assume that the winding connections are properly made. If a wattmeter is available, a further check might be made on the total watts taken by the motor running light, but that does not add greatly to the ammeter check. The connections for connecting two wattmeters in a two-phase four-wire circuit are given in Fig. 4 and for a three-phase circuit in Fig. 5. The connections for a three-wire two-phase would also be the same as those in Fig. 5; where only one wattmeter is available, it may be connected into a three-phase circuit with a single-pole switch, as in Fig. 6, so that the two readings may be taken by simply throwing the switch. In a two-phase circuit the total watts will always be the sum of the two readings, but in a three-phase circuit this is true only when the power factor is greater than 0.50. Where two wattmeters are used to measure the no-load watts of a three-phase motor, the difference of the two readings gives the correct value of the watts, since the power factor of an induction motor at no load is always less than 0.50. The watts taken at no load and full speed and voltage cover the iron loss, bearing friction, windage and a small amount of copper loss. The total no-load watts will in general be in the order of 5 per cent to 8 per cent of the rating of the motor in watts varying with the capacity and speed of the motor. The motor rating in watts would be the horsepower from the nameplate multiplied by 746.

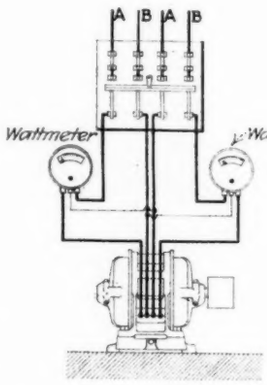


FIG. 4. WATTMETER CONNECTIONS FOR FOUR-WIRE TWO-PHASE MOTOR

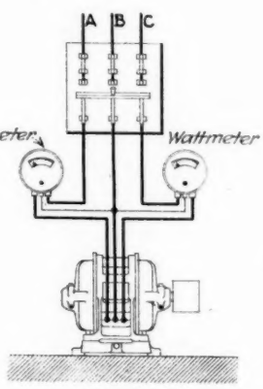


FIG. 5. WATTMETER CONNECTIONS FOR THREE-PHASE MOTOR

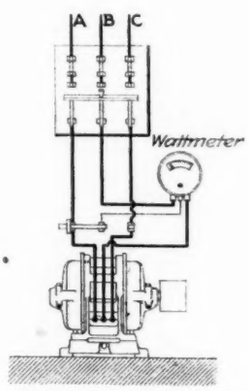


FIG. 6. ONE WATTMETER CONNECTED TO A THREE-PHASE MOTOR

If the foregoing checks indicate that the motor is not acting normally, they should also give some evidence that there is a fault in the coils of the winding or in the manner in which these coils are connected, and further search is made to analyze the nature of this fault so that it may be located and corrected.

Refrigeration Study Course—IV. The Ammonia Condenser

By H. J. MACINTIRE

Professor of Mechanical Engineering, University of Idaho

IN THE previous part of this course it was brought out that in the simple refrigerating plant there was but one moving piece of apparatus; that is, the compressor. The compressor is the pump which, by increasing the pressure of the gas from the refrigerating coils to one some six to twelve times as great, makes it possible to use the same ammonia continuously. The compressor pumps the compressed gas into a condenser, which is water-cooled, and which makes it possible to cool the gas to a point where it condenses (still under pressure) and becomes all liquid again.

Physical State of Ammonia

For some reason or other there seems to be some difficulty in understanding the condenser, and yet it is not difficult if the reader comprehends the principles involved. First, one should understand clearly the three physical conditions that are involved in the condenser and see if they, too, are not conditions met with in steam-engineering practice.

In steam-boiler practice we have to feed water to the boiler at, say, 210 deg. F., and it is heated as water to 370 deg. F., and then at the corresponding pressure it begins to boil. No boiling occurs until the temperature corresponding to the boiler gage pressure is obtained. As the boiler pressure is constant, boiling continues at 370 deg. F. and the steam given off is said to be saturated. It is not *dry* and saturated unless some means is provided to separate the particles of liquid which are thrown into the steam space by the violence of the boiling. If a superheater is attached to the boiler, or if the boiler design is such that the *steam* comes into contact with more heating surface, like the upper part of certain vertical boilers, the steam is heated some more and the temperature increases much beyond 370 deg. and it is said to be superheated.

In the ammonia refrigerating system the gas from the refrigerating coils (the steam boiler of this system) is supposed to be just dry and saturated. If some of the coils convey dry ammonia gas, or if dry gas passes through uninsulated return lines, then heat will pass through the pipes and will increase the gas temperature. (Really we try to perform refrigeration with a dry gas.) The ammonia then becomes *superheated,* which will be shown later to be detrimental to the compressor capacity. In any case, however, the discharge gas from the compressor is superheated, varying in amount from 60 to 200 deg. F. superheat—figured from the temperature of saturation at the condenser pressure. So in the refrigerating coils it is quite possible to have the conditions of liquid ammonia, wet gas, dry and saturated gas and even superheated ammonia. These same conditions occur in the condenser, but in the reverse order.

The Ammonia Condenser

The compressor, as mentioned, takes the gas either dry and saturated, or slightly superheated, and compresses it, thereby discharging into the condenser a superheated vapor. This condenser is an arrangement of piping, with suitable fittings, so that the gas may pass through along a carefully prescribed path and be in *metal* contact all the time with the condensing water. As the gas is made to pass through a long path kept cool by the water, the superheat is first removed, then the heat necessary to condense it, and finally the liquid may be cooled below the temperature of saturation.

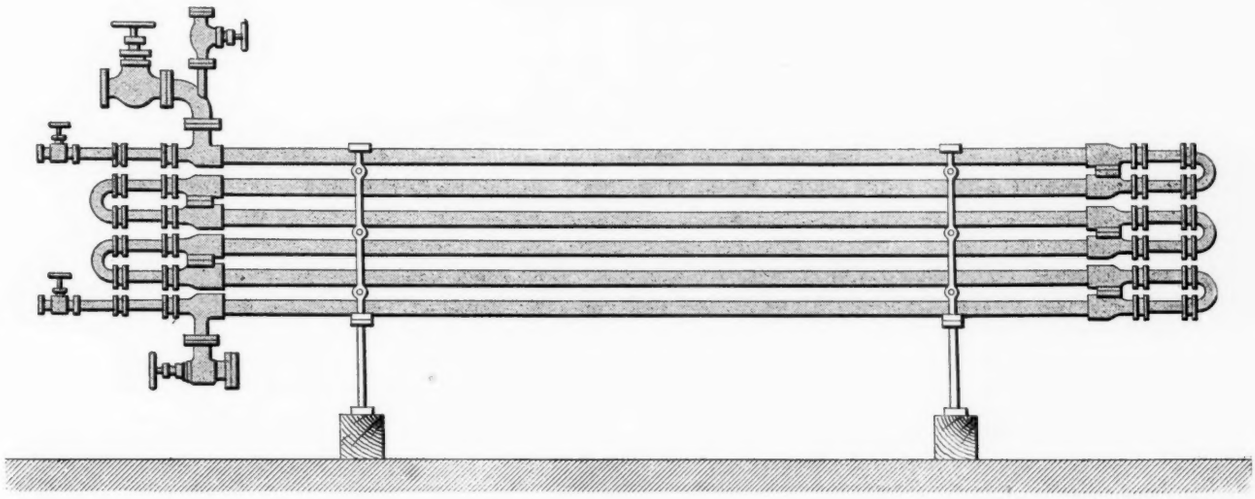


FIG. 1. THE DOUBLE-PIPE AMMONIA CONDENSER

The condenser, then, is simply a device to take heat away from the compressed gas. But it is not as simple as it at first sounds, because we desire to do the cooling with as little water as possible, as well as by using as little piping as is practicable. If we use little water, and heat it considerably—say 15 to 20 deg. F.—then we will increase the head pressure, as the head pressure is dependent on the temperature at which liquefaction takes place. If we use quite a little water, with a water temperature rise of 5 to 8 deg. F., then the cost of pumping water assumes larger proportions. But

more important than all is the question of heat transfer. In the steam surface condenser the water usually passes through the tubes and the steam impinges perpendicular to the tubes. In this steam is a little air, which seems to stick to the tube and forms an insulation air film around the tube, as shown in the figure. The result is a much-reduced heat-transmission rate, and it takes two or three square feet to do the same amount of work that would be required of one square foot without the insulating film. In a steam condenser the air is removed constantly by means of an air pump, this being necessary on account of the high vacuum carried, and the continual air leaks which cannot be prevented.

The Gas Film in the Condenser

In the ammonia condenser there is always some air as well as decomposed ammonia and oil, all of these tending to the formation of a gas film. However, here there is a difference in that, as the flow of the ammonia is along the tubes, there is a tendency to scrape off this film if there is some place for the accumulated gas to go. For instance, in the bleeder type of condenser the gas enters at the bottom and passes upward, suitable provision being made so that the liquid ammonia may be drained or bled off as it is condensed. The idea here is, as it is in the steam condenser, that the best efficiency may be obtained by operating the condenser with as little liquid in the pipes as is possible. In the flooded condenser, the double-pipe, and the atmospheric types, the gas from the compressor enters at the top and works downward so that the lower pipes are partly or, possibly, completely filled with liquid ammonia. In the figure it is seen how this affects the action of the condenser, inasmuch as the effective area of the pipes is reduced in proportion to the area exposed to the liquid.

In addition to the effect of a gas film, or accumulated liquid, on the pipe surface, there is the effect of oil and scale. This is not a question of design, except that the right kind of condenser should be chosen for the kind of condensing water available at the plant. Boiler tubes require cleaning for economy as well as safety, and ammonia condensers have a similar need. The condenser must be easily cleaned, and cleaning should be performed frequently enough to prevent the solid matter forming a hard scale.

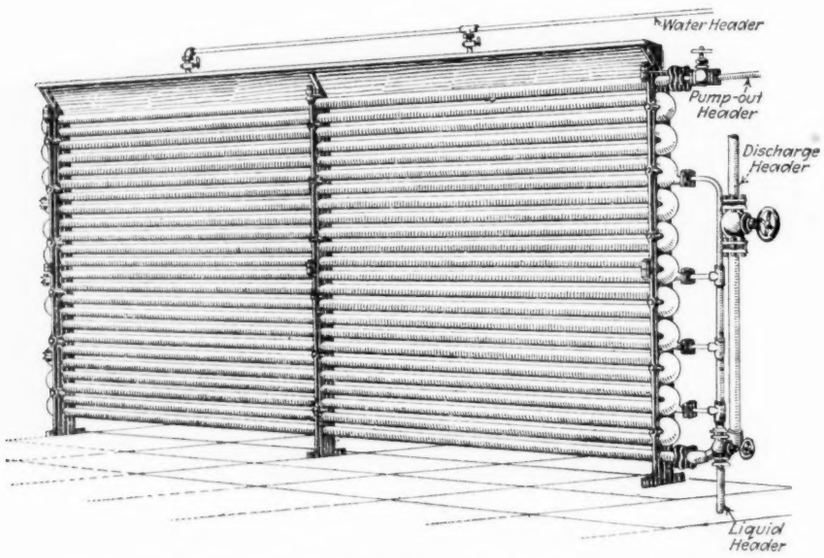


FIG. 2. SHOWING THE ATMOSPHERIC TYPE AMMONIA CONDENSER

In condensers, as well as other heat transferring apparatus, there are three factors that affect the quantity of heat conducted through the walls of the pipes: The area, the coefficient of heat transfer, and the temperature difference in the two sides of the pipe. The product of these three quantities will give the number of heat units transferred per hour or per 24 hours. The area is taken in square feet, and the coefficient of heat transfer is found by experiment and is affected by the kind of metal used, its thickness, the condition of the surface, whether oily or scaly, or whether a gas film is around it. The temperature difference requires a little more explanation.

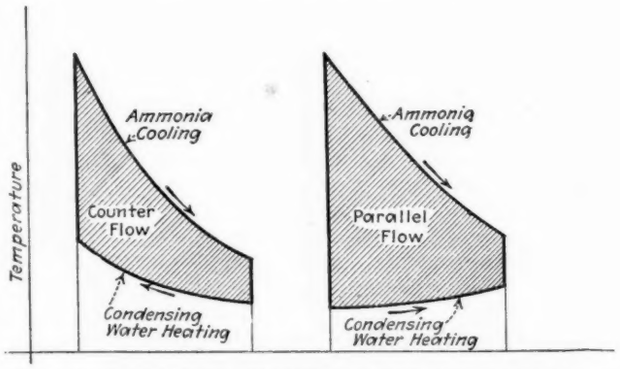


FIG. 3. EFFECT OF COUNTER FLOW AND PARALLEL FLOW THROUGH AMMONIA CONDENSERS

In Fig. 3 it is attempted to show the action taking place in the condenser. Two cases are shown, one representing parallel flow of the gas and water, as in the atmospheric type of condenser where the water flows out of a trough and then falls first on one pipe and then on another; the other is a counterflow of the gas and water as in the bleeder type of condenser or the double-pipe condenser. From the diagram it will be seen that parallel flow and counterflow do not give the same results. What is desired most particularly is to get as cold a liquid ammonia as is possible, because it has been found that more refrigerating capacity is obtained thereby, and the condenser pressure is lowered. Therefore it is most desirable to bring the coldest water in contact with the coldest ammonia, and the warmest water where the compressed gas enters. To show how this works out in practice it may be said that the usual specification for the atmospheric type of condenser is 60 lin. ft. of 2-in. pipe, but only 30 lin. ft. for the bleeder type, using the same liberal factor for safety.

A type of condenser that was regarded with considerable favor some time ago was the flooded condenser, a design which is now being discarded. The idea in this arrangement was that the coefficient of heat conductivity in the condenser from the gas to the water was very low in value, but if the surface could be wetted then results would be better. The great difficulty here, however, is in preventing what the name implies, because flooding the condenser means choking it up with liquid ammonia so that the conduction of heat is retarded instead of being accelerated. The action of the

condenser is to install an injector so arranged that the gas from the compressor passes through and drags some liquid ammonia from the liquid receiver and the gas and liquid mixture passes through the condenser, as in the ordinary design.

Condenser Capacity

As regards the capacity of an ammonia condenser, the condition is similar to that of a steam boiler of the water-tube type. We usually rate such a boiler at 10 sq.ft. of heating surface per boiler horsepower; yet there are cases where such boilers have developed 2, 2½, 3 or even more boiler horsepower for every 10 sq.ft. of heating surface. It depends on the condition of the water, the tubes and the ability to burn fuel under the tubes. In like manner the condenser may be able to do cooling at the rate of 12, or 10, or even 6 sq.ft. per ton of refrigeration, and yet we would not be justified in using such small surfaces. The efficiency of the condenser may drop off, some stands may be laid down for repair, or perhaps storage volume may be required for the liquid ammonia during times when repair work on the low-pressure side is required.

The most important function of the condenser is the determination of the condenser pressure, which determines directly the work done by the steam engine in the electric motors. If no air were present, or decomposed oil or ammonia, then the condenser or head pressure would be determined by the temperature at which liquefaction took place. And the temperature of liquefaction is determined directly by the amount of cooling showered over the condenser and its temperature. As an example, we may say that in acquiring a ton of refrigeration, the liquid ammonia in the expansion coils will absorb heat at the rate of 200 heat units (200 B.t.u.) per minute. Additional heat, amounting to about 60 heat units, is added during compression, so that the total heat to be removed by the cooling water in the condenser is about 260 heat units per ton of refrigeration. This has to be taken away by the cooling water, which is heated in consequence. This could be done by $\frac{260}{10} = 26$ lb. (3.1 gal.) of water per minute heated 10 deg. in temperature, 19½ lb. (2.34 gal.) when heated 15 deg., or 13 lb. (1.36 gal.) when heated 20 deg. The table shows what can be obtained in practice.

GALLONS CONDENSER WATER PER TON REFRIGERATION

Condenser Pressure, Lb. Per Sq. Inch, Gage.	Corresponding Temp. Deg. F.	60 Degrees F. Water				60 Degrees F. Water				80 Degrees F. Water				90 Degrees F. Water			
		Range, Deg. F.	Water Per Ton of Refg'n. Gal. Per Min. Suction Pressure, Lb. Gage			Range, Deg. F.	Water Per Ton of Refg'n. Gal. Per Min. Suction Pressure, Lb. Gage			Range, Deg. F.	Water Per Ton of Refg'n. Gal. Per Min. Suction Pressure, Lb. Gage			Range, Deg. F.	Water Per Ton of Refg'n. Gal. Per Min. Suction Pressure, Lb. Gage		
			15	20	25		15	20	25		15	20	25		15	20	25
126.4	75	10	2.90	2.85	2.80												
131.4	77	12	2.40	2.35	2.30												
136.6	79	14	2.05	2.00	1.95												
141.8	81	16	1.85	1.80	1.75	6	4.87	4.80	4.70								
147.2	83	18	1.65	1.60	1.55	8	3.67	3.60	3.55								
152.7	85	20	1.47	1.45	1.41	10	2.95	2.90	2.85								
158.3	87	22	1.35	1.32	1.30	12	2.45	2.40	2.35								
164.1	89	24	1.25	1.22	1.20	14	2.10	2.05	2.00								
170.1	91	26	1.15	1.13	1.10	16	1.90	1.85	1.80	6	5.00	4.90	4.80				
176.2	93	28	1.08	1.05	1.03	18	1.68	1.63	1.60	8	3.75	3.70	3.65				
182.6	95	30	1.00	0.99	0.97	20	1.50	1.48	1.45	10	3.00	2.95	2.90				
189.1	97	32	0.95	0.93	0.90	22	1.38	1.35	1.32	12	2.52	2.48	2.43				
195.7	99	.....	.....	.....	.....	24	1.28	1.25	1.22	14	2.13	2.10	2.06				
202.5	101	.....	.....	.....	.....	26	1.17	1.15	1.13	16	1.92	1.85	1.83	6	5.10	5.00	4.90
209.5	103	.....	.....	.....	.....	28	1.10	1.07	1.05	18	1.70	1.67	1.63	8	3.83	3.75	3.70
216.5	105	.....	.....	.....	.....	30	1.02	1.00	0.98	20	1.53	1.50	1.48	10	3.07	3.00	2.95
223.7	107	.....	.....	.....	.....	32	0.95	0.93	0.92	22	1.40	1.37	1.35	12	2.57	2.51	2.47
231.1	109	.....	.....	.....	.....	.....	.....	.....	.....	24	1.30	1.28	1.25	14	2.19	2.13	2 10
238.7	111	.....	.....	.....	.....	.....	.....	.....	.....	26	1.20	1.16	1.15	16	1.95	1.90	1.88
246.5	113	.....	.....	.....	.....	.....	.....	.....	.....	28	1.12	1.08	1.06	18	1.74	1.69	1.65
254.5	115	.....	.....	.....	.....	.....	.....	.....	.....	30	1.05	1.02	1.00	20	1.56	1.53	1.50
262.7	117	.....	.....	.....	.....	.....	.....	.....	.....	32	1.00	0.98	0.95	22	1.43	1.40	1.37

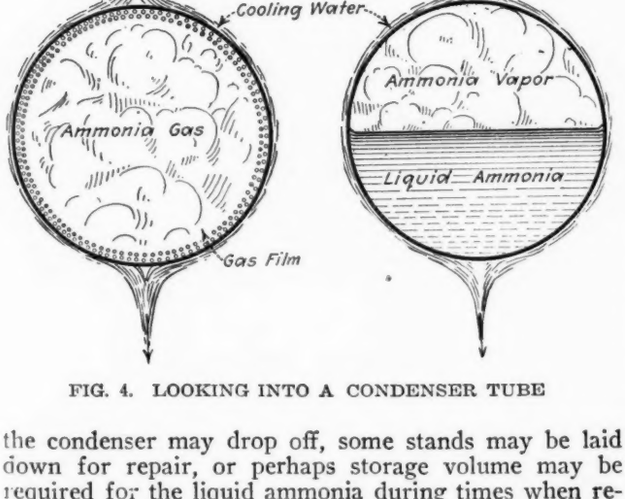


FIG. 4. LOOKING INTO A CONDENSER TUBE

How 25-Cycle Alternating Current Came Into Use

In a paper, "The Technical Story of the Synchronous Converter," presented before the St. Louis Section of the American Institute of Electrical Engineers, Jan. 28, 1920, B. G. Lamme said in part:

It was not until 1892 that deliberate efforts were made to transform, on a commercial scale, from alternating to direct current. It was becoming recognized that the polyphase system offered great future possibilities, and the synchronous converter began to be looked upon as one of the accessories of such a system. In consequence, arrangements were made to obtain tests on a relatively large scale to determine the possibilities of such a device. For this purpose, a standard 150-hp. 500-volt 850-r.p.m., four-pole belted-type railway generator was equipped with four collector rings placed over one end of its commutator. Suitable brush-holders were arranged for operating on these collector rings, in addition to the usual direct-current brush-holder equipment.

From the first this machine operated in a very satisfactory manner as a synchronous converter, and a long series of tests were carried on by the writer, assisted by N. W. Storer, at that time one of his associates in the testing room. It was determined that this machine

would commutate in just as satisfactory a manner as when acting as a direct-current generator. As far as could be observed, the machine in every way was a practical one.

Meanwhile the whole synchronous-converter situation was being worked over, and it was decided that 3,600 alternations (30 cycles) was about the best frequency for such machines. This was slightly higher than the frequency at which the tests were being made, but it was felt that this increase was permissible, in view of the excellent results already obtained at 3,400 alternations (850 r.p.m., four poles). In those days everything was measured in alternations per minute instead of cycles per second as in present practice.

About this time a commission, which had taken up the development of the Niagara Falls power, had begun negotiations with the Westinghouse company, with a view to getting certain electrical machinery constructed according to the designs of the commission. The principal apparatus involved was an electric generator of 5,000-hp. capacity at 250 r.p.m. The design contemplated was the "umbrella type" with external rotating field and vertical shaft. This construction as a whole was considered practicable by the Westinghouse engineers, but the electrical proportions of these generators were not acceptable. The commission had decided upon a frequency of 2,000 alternations per minute (eight poles and 250 r.p.m., now 16⅔ cycles per second). One of the objects in this low frequency was to be able to operate commutator-type motors by means of alternating current, as certain members of the commission believed that this was the solution of the small alternating-current motor problem.

The Westinghouse company objected to this low frequency and proposed, as an alternative, 16 poles at 250 r.p.m., giving 4,000 alternations per minute, or 33⅓ cycles, this being the nearest that could be obtained to its own proposed standard of 30 cycles. There was considerable discussion on the merits and demerits of these two frequencies. One of the advantages claimed for the higher frequency was that it would be much more suitable for synchronous converters, as the possible combinations of poles and speed would be very much greater than for 16⅔ cycles. In fact, the lower frequency was considered to be more or less prohibitive as regards small or moderate capacity synchronous converters and induction motors, as their speeds would be too low. It is interesting to find how thoroughly this problem was appreciated even at that early date, when only one experimental converter had been placed on test.

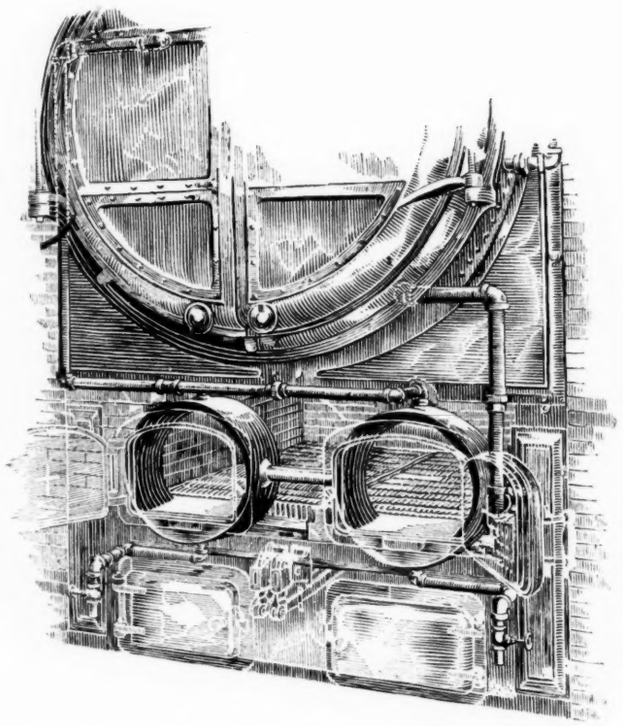
A compromise was finally made on the question of frequency by selecting a 12-pole machine for the Niagara generator, thus giving 3,000 alternations, or 25 cycles. This was the origin of 25 cycles as a standard. The decision was made largely on the basis of future possibilities in the way of synchronous converters and induction motors.

Smith Door Protectors

One of the large items of upkeep expense with hand-fired boilers is that of maintaining in condition the front masonry, door linings and boiler fronts. If the boiler furnace is forced hard, new door linings, arches and side walls are necessary at least once a year.

A device designed to eliminate the necessity of these frequent repairs is known as the Smith door protector, manufactured by the International Engineering Works, Inc., Framingham, Mass. The protector is made of firebox steel of the same quality used in the boiler itself. The outside is circular in form and made with openings for pipe connections. They are set back at the front of the boiler and are piped so that the water is taken from the lowest part of the boiler, flows through the protectors and then back to the upper part of the boiler. This affords direct and constant circulation from the boiler to the protector and back again. The lower section of each protector is below the grate level, and a dead plate is set in the protector at the grate line. The bottom of each protector is connected to a blowout pipe. As the lower section of the boiler is below the grate line, a sediment chamber is formed so that any scale or other foreign matter in the water will be precipitated and easily blown out. Each protector is made of the proper size to fit the door opening for which it is to be used.

The inside section is rolled up and flanged out against the outside shell, and the two are welded together, making a practically seamless construction that is not affected by contraction or expansion and thus eliminates the use of bolts or rivets. The only alteration to the boiler in making this installation is the tapping of two holes in the tube sheet for the water connection and the piping from the blowout of the protector to either the ashpit or the boiler blowoff pipe.



DOOR PROTECTORS APPLIED TO A BOILER FURNACE

For several years the United States has produced approximately 65 per cent of the world's output of crude oil and has contributed about 60 per cent of the total amount produced in the world to date. The United States Geological Survey estimates that our reserves are approximately 40 per cent exhausted. Development and exploration work is not affording any positive evidence of relatively large new discoveries, while demands for petroleum are increasing. On the other hand, large potential reservoirs are lying dormant in other parts of the world which, if they can be developed, will supply the world's demands for some time. When these sources fail or become too high-priced, the country can fall back on our tremendous reserves of oil shales.

EDITORIALS

Where Electricity Is a Luxury

THE recent decision of the Idaho Public Utilities Commission has apparently exploded the idea that the time would come when not only would the heavy parts of all our tasks be performed by energy transmitted electrically, but also our homes and buildings would be heated—in fact, everything that required light, heat or power would be done electrically. In the early developments of the large irrigation enterprises in the State of Idaho, the Great Shoshone and Twin Falls Power Company was formed, and later the United States Government constructed a hydro-electric plant in connection with its irrigation project on Snake River. In both of these developments there were large quantities of excess energy, and to provide a sufficient demand for the current during the winter months a very cheap rate was put into effect for current used for heating purposes. These rates took into account only the additional cost of equipment necessary to deliver the current to the customer, consequently, the charge was considerably below the actual cost, had the total investment been taken into consideration.

When, during the war, there was an increased demand for power and an increased cost of coal for fuel purposes, there was considerable discussion as to the advisability of compelling the hydro-electric power companies of the state to install sufficient capacity to take care of the demand for current for general heating purposes. To determine the cost of this service, the Public Utilities Commission started an investigation, the findings of which have been very clearly set forth in the January number of the N. E. L. A. Bulletin, by Commissioner George E. Erb.

The facts brought out during the hearings showed that it is impossible to furnish electricity for house heating in competition with coal or wood. For open-air heating it would cost from four to six times as much when electricity is used and charged for at a rate that would pay a reasonable return on the investment necessary to render the service. Only where there is an excess of power that may be supplied for heating can this be done, and even then it is questionable. In the case of the Idaho Power Company the taxes paid per kilowatt-hour sold were more than the gross return on a kilowatt of energy for house heating.

In many of the irrigation projects the water has to be supplied by pumps driven by electric motors, and in these cases it was found that the heating load of the winter season overlapped the summer pumping load from four to six weeks both fall and spring, making it necessary to install considerable additional capacity if both interests were to be adequately served, with an attending increase in cost of the service. The period of greatest demand for current for heating in the intermountain regions is at a time when there is a minimum flow of water. This is due not only to low water, but also to freezing. The increased demand that has developed during recent years for water for irrigation purposes has made it necessary to store the water in reservoirs during the winter months for use during the summer. This practice has materially limited the power possibilities of some of the streams of Idaho. When it is considered that the power plants in the State of Idaho are favorably located for supplying power to their customers, the foregoing facts apparently give very little hope of using electricity for general heating purposes even when supplied from favorably located hydro-electric plants, except as a luxury, and this, in substance, was the finding of the commission.

There is little doubt that electricity is one of the greatest servants at the command of man, but, like all other great agents, it is not now, nor will it ever be, a catholicon for all our industrial and economic problems; but if intelligently used it can be of great economic value. This stands out plainly in the State of Idaho as brought out in the testimony before the commission.

An enormous economic waste is constantly going on in the use of coal for power, especially for firing railway locomotives. This waste is not confined to the locomotive, but includes the loss of power necessary to transport the coal. Would it not be more in keeping with the economic utilization of our natural resources to use hydro-electric power where available for operating our railways, or where this is not available, to burn the coal in economic power plants and supply electric energy to drive the locomotive—when one pound of coal burned in the former will do the work of three burned in the latter—and until such times as there will have been discovered a cheaper method of generating and transmitting power than at command at present?

Power Shortage on the Pacific Coast

IT MAY be that some day the East in general and Congress in particular will know and grasp the power situation on the Pacific Coast. They do not know it now. It is not unfair to say that the East has not the faintest conception, not to say adequate knowledge, of what the West has in the way of potential and developed power, nor does it realize how vital is power to the very life of this great and rapidly growing part of the country.

Agriculture and horticulture are the two great pursuits of the Coast from Seattle on the north to San Diego on the south. The average American, who knows more about Russia than he does about the San Joaquin and the Yakima valleys, cannot for the life of him see why a farm needs power other than that for the tractor and the Ford. He does not know that at this very writing every power company on the Coast is wofully overloaded furnishing electricity to farms and has booked so much farm business that the matter of delivery is a veritable nightmare to those responsible. This is particularly true of California, though most of the plants in the Northwest also are overloaded with farm and lumber industry consumers.

At present the "rainy season" in California is about half over and there is a shortage of more than eight inches of rain. From a power standpoint this has created a desperate situation. Every kilowatt of steam-generating capacity that can be unearthed and set to work is eagerly sought. While it may be true that the

question of reserve steam stations has not taken a new turn in the minds of engineers here, it is certain they are thinking about the question with an intensity which is more marked than ever. Oil is becoming so high in price that every day some additional engineer joins the ranks of those who are ready to look upon it as a prohibitive fuel. This oil is, of course, a California product, little or no Mexican oil having yet found use here. The natural gas available is of low heat value and heretofore so expensive that it found but small market in power plants. However, one large company in the southern part of the state is completing a large steam station using natural gas.

The serious power shortage may, nevertheless, have a happy ending in that it will direct such attention to the matter of fuels for steam stations that not only will there be a greater percentage of steam power, but the stations may become of such an efficient character both in design and operation that it will be worth while finding service for them that will be of regular instead of an emergency character. This much is certain—a given sum of money will go farther building steam stations to meet certain load conditions, the time element considered, than is true for hydro-electric developments.

The engineers of the Coast know better than outsiders can possibly know what is the solution of their power difficulties, but the problem is a Coast one in particular and a national one in general. It is this that the country as a whole should, but does not, realize.

"Better Safe Than Sorry"

FROM an advanced summary of the 1917 mortality statistics received by the National Safety Council from the United States Census Bureau, the total number of accidental deaths in the area of continental United States under registration amounted to 53,544, as against 60,072 during the previous year. The reduction of 6,500 in the number of deaths is attributed to the accident-prevention movement of the last few years. It is gratifying to learn that America is gradually becoming less careless. Standardizing and making uniform the large number and variety of safety codes now in existence, a movement that is now under way, should reduce the cost of accident prevention and make the work more effective.

Perfecting the safety codes and making them uniform, however, is only part of the battle, as statistics show that over one-half of the accidents in the commonly accepted hazardous class are controlled by the personal equation and are due largely to carelessness arising partly from a lack of discipline and a natural disinclination to follow orders.

In hazardous work, such as that of the power plant, it is interesting to note the relative percentages of accidents. Electric current, moving machinery and steam explosions contribute but twelve per cent. This figure may be compared to 16.2 per cent credited to slipping and falling, 18.6 per cent to handling tools and 19.5 per cent to handling material. Nearly a quarter of the injuries due to falls were not from scaffolds, poles or other elevations, but occurred on the level where least justified.

Personal carelessness, then, and contributory negligence on the part of associates, are the leading causes of accident. Eliminate these factors, and immediately the number of accidents is reduced by one-half. No elaborate or costly equipment is required. The attitude of the executives will have a bearing, but the real solution lies with the worker himself. Be careful! It is better to be safe than sorry.

Needed, a New Association

THERE has been in existence in England for several years past an association of Diesel-engine users, made up of men who build, own and operate Diesel engines. Its meetings not only afford an excellent opportunity for an exchange of views and mutual help among operators, but also an opportunity for the designer to profit by the experience of the men who actually own the engines. The results have more than justified the founders of the association.

The use of oil engines is growing so rapidly in the United States that such an association is needed badly. At present papers on oil engines are occasionally given before various engineering societies, and their usual reception is concrete evidence that engineers are keenly interested in the subject. But the men who take part in these discussions are usually concerned with the building of the engines, and seldom does the operating man enter into them. On the other hand, there is an occasional talk on the subject at a meeting of one of the operating engineers' meetings, but here they are necessarily restricted through not gaining the designers' viewpoint.

To get the best out of any piece of power-plant apparatus, and especially an oil engine, there should be the closest coöperation and confidence between builder and operator. Often, equipment is discredited because of misunderstanding upon the part of the operating man, whereas a frank exchange of ideas with the designer would have resulted in eliminating the cause of the trouble.

While it is true that geographical limitations in England make it easier for Diesel-engine men to get together than in this country, where they are more scattered, still there are certain well-defined regions where the use of the oil engine is most general, and it is within these regions that such a movement could be started.

Mr. Lane's Constructive Work

ON MARCH first Franklin K. Lane will relinquish his post as Secretary of the Interior and retire to private life. His going will be regretted by all, regardless of party affiliations.

Mr. Lane leaves a record, covering seven years of broad and constructive administration, that has entitled him to front rank in the Cabinet. In fact, he has generally been regarded as the most popular of the President's official advisers.

The Department of the Interior houses numerous bureaus dealing with many diversified subjects, and its head must possess versatility second to none. With the combined training of a lawyer and a journalist, Mr. Lane has been enabled to see the broad economic possibilities of our natural resources and the necessity for their further development in a way that will bring greatest prosperity to the country. Moreover, he has shown a keen grasp of the more or less technical and engineering details as pertain to our fuel supply, water-power development and power problems in general. He has been an ardent champion of the "super-power plan" and last year urged Congress for an appropriation to cover a survey of the power situation in the Atlantic Coast section. Had Congress acceded to this request, we would have been in a position to meet more intelligently the fuel conditions confronting that section today.

Mr. Lane was also solidly behind the water-power bills that recently passed both houses of Congress and are now in conference. If they finally become law, as indications point they will, much credit will be due him.

CORRESPONDENCE

Averaging Pressure Charts

The article by W. V. White on "Averaging Pressure Charts," on page 669 of the Oct. 28-Nov. 4, 1919, issue of *Power,* should not pass unchallenged. It is a source of some surprise that the fallacy of endeavoring to average circular charts by means of the ordinary planimeter is not commented upon, since this subject was thoroughly threshed out years ago in *Power.* Reference is made particularly to the issues of Mar. 3 and Mar. 31, 1908; Oct. 2 and Nov. 24, 1913, which lead to the correct conclusion that the mean value of the squares is not the same as the average diameter.

Several special planimeters have been devised for solving the problem, including the Durand, described in *Power,* Mar. 23, 1911, and instruments manufactured by Builders Iron Foundry, Bristol Co. and General Electric Co.

Polar planimeters can be used on circular charts with practically accurate results only when the charted line is confined to a narrow zone; the error may be very large otherwise. CHARLES G. RICHARDSON.

Providence, R. I.

Why Does the Water in a Boiler Lift When the Safety Valve Blows?

On page 715 of the Nov. 11 issue I read Charles L. Anderson's version of "Why Does the Water in a Boiler Lift When the Safety Valve Blows?" Mr. Anderson believes that the A. S. M. E.'s removal of the limit as to the size of safety valves is not progress; I agree with him.

I have had boilers with three 5-in. safety valves, and I believe 5-in. valves to be too large. One day, by accident, two of these valves blew at the same instant on one boiler, with the result that a jet of water came from each escape pipe with tremendous force. As soon as the blowing was over, one valve spring was eased to allow that valve to blow a couple of pounds earlier. One of these valves blowing at a time did not carry water with the steam.

Some years ago I was engineer on a small steamboat that carried a water-tube boiler. On one bell the water would stay at two gages, but on the jingle bell, if caution was not used the water would lift out of sight in the glass. If the throttle was pulled open very gradually, the water would remain in the glass at perhaps 2½ gages and then settle to where it belonged.

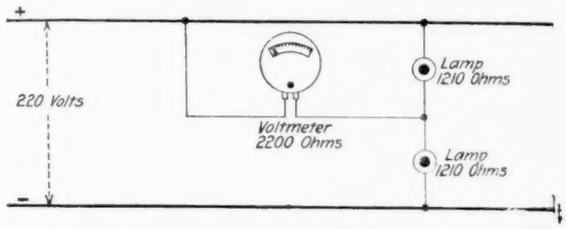
I believe the large opening relieves the pressure too quickly, and then the water flashes into steam so rapidly it spills over, as it were. I know of a case where water was being taken over by the turbines to the extent that the blading had to be scraped perhaps twice a year. After the holes in the dry pipes in the boilers were reamed out a few sizes larger, no more water was taken over. This was a station of several thousand kilowatts, and it took some time to remedy the trouble, but the enlarged holes did the trick.

I know of a case where the water was being carried at one gage in a battery of horizontal-tubular boilers and the engine was getting large quantities. It was suggested that the water was so low that the top row of tubes was throwing it up with the steam. The water was raised to two gages and the engine took very little water after that. C. W. PETERS.

New York City.

Extending the Range of Voltmeter

Referring to the method of "Extending the Range of Voltmeter" in the Nov. 11-18, 1919, issue of *Power,* it is necessary to take into consideration the wattage of the lamps employed, as the method described is not theoretically correct and is only approximately correct when 200-watt lamps are used, the error decreasing as the size of lamps is increased.



VOLTMETER CONNECTION FOR MEASURING DROP ACROSS ONE LAMP

In order to calculate the error, assume that two 10-watt lamps, each having a hot resistance of 1,210 ohms, are used on a 220-volt circuit. Assume the voltmeter resistance is 2,200 ohms, as indicated in the figure, a fair value for a dynamometer type. The joint resistance of the voltmeter and one lamp in parallel equals $\frac{1}{\frac{1}{2,200}+\frac{1}{1,210}} = 780$ ohms. This is in series with the other lamp of 1,210 ohms, making the total resistance of the circuit equal to $780 + 1,210 = 1,990$. By Ohm's law the current in the circuit will be $I = \frac{E}{R} = \frac{220}{1,990} =$ 0.11 ampere, and the volts drop across the voltmeter is equal to the resistance of this section of the circuit times the current or $780 \times 0.11 = 86.8$ volts. Since connecting the voltmeter across the other lamp will give identically the same results, then the sum of the two readings

would be 86.8 + 86.8 = 173.6 volts, which Mr. Nichols says should equal the line voltage. These figures show that the meter in this case would read 21 per cent. low when using 10-watt lamps.

But if we substitute 200-watt lamps each having a resistance of 60 ohms, then the joint resistance of one lamp and voltmeter is 58.4 ohms, and the drop is 108.3, which is only 1.3 per cent. low. Using larger lamps still further reduces the error, but it can never be reduced to zero. PHILLIP A. LITTEL.

Orange, N. J.

[If the foregoing measurements had been made on a direct-current circuit with a voltmeter of the permanent-magnet type, having a range of about 150 volts, and using ordinary 25-watt tungsten lamps, which is a very common type, the percentage of error would be practically negligible. The hot resistance of the lamps would be about 302.5 ohms and the resistance of the voltmeter 15,000 ohms. Working this out, the voltmeter reading will be 109.4 volts, or 0.55 per cent. error. This would be in general the conditions we would expect to find on a direct-current circuit. However, on an alternating-current circuit the error will be greater on account of the lower resistance of the voltmeter; the error being somewhere between the extremes given by Mr. Littel, probably in general around 4 or 5 per cent. Of course if care is used to obtain high wattage lamps, the error would be small. In emergency makeshifts whatever comes handiest is most generally used, and in this case lamps of 40- or 60-watt capacity are the ones that would in general be most likely to be available. —Editor.]

Demagnetizing a Watch

An old-type Edison bipolar generator has an extremely large magnetic leakage. In working around one of these machines my stop-watch became magnetized so that when I snapped the watch to start, the resetting lever dragged the cam to its point before releasing, thus moving the hand from 0 to 30 sec. in a small fraction of a second, before the wheel engaged with the watch mechanism.

To demagnetize it, I took a coil about 5 in. in diameter, consisting of 600 turns of No. 30 B. & S. gage magnet wire, and connected it to 110-volt 60-cycle circuit. Then tying the watch to a piece of string and twisting it so that it would spin around, I passed it through the coil with the watch spinning rapidly. There was not a trace of permanent magnetism left in the watch after performing this operation once. V. H. TODD.

Orange, N. J.

Fuel Savings by the Economizer

Statements published in books that by the use of an economizer the fuel consumption can be reduced from 10 to 20 per cent. are of no great use to an engineer except as a matter for comparison. What an engineer wants to know is how much fuel can be saved by its use in his own plant.

Some years have passed since I came to my present plant, but it was only this year that I got a chance to fully realize what a clean economizer meant, when one was cut out to have the tubes bored.

We have a 28 series (8 pipes in each series) economizer attached to three Lancashire boilers operating with 160 lb. pressure. The average injection water temperature is 100 deg.; hotwell temperature, 130 deg.; economizer outlet temperature, 275 deg. F.

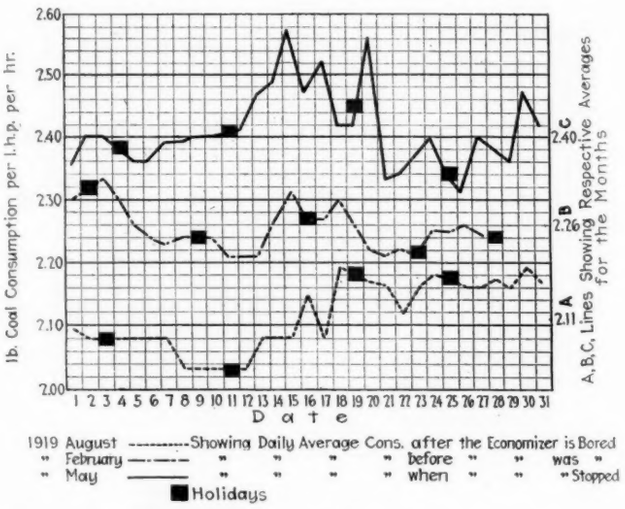
From the accompanying chart the average coal consumption per indicated horsepower per hour will be seen to be 2.26 lb. per i.hp. before the economizer was stopped; 2.40 lb.i.hp. per hour when the economizer was stopped; and 2.11 lb. i.hp. per hour when the economizer was started again.

Then, 2.40 — 2.11 = 0.29 × 100 ÷ 2.11 = 13.7 per cent. the amount of the fuel that can be saved by the use of the economizer. But 2.40 — 2.26 = 0.14 and 0.14 × 100 ÷ 2.26 = 6.15 per cent. Therefore but 6.15 per cent. of the fuel was being saved before economizer tubes were bored. This was due to scale, which was about one inch thick in the tubes. Therefore, only half the percentage of the fuel can be saved by permitting the tubes to work with a thick layer of scale.

Further, 2.26 — 2.11 = 0.15 and 0.15 × 100 ÷ 2.11 = 7.1 per cent. Therefore, 7.1 per cent. greater saving in fuel is being made by the economizer after it was cleaned of scale than before being cleaned.

On the whole, I found that about 13 per cent. of the fuel can be saved by the use of the economizer in my own plant.

Moreover, the same was the case when our economizer was stopped for boring the tubes seven years ago,


lb. Coal Consumption per i.h.p. per hr.
2.60
2.50
2.40
2.30
2.20
2.10
2.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Date
A
B
C
2.11
2.26
2.40
A, B, C, Lines Showing Respective Averages for the Months
1919 August ---------Showing Daily Average Cons. after the Economizer is Bored
" February — — — " " " " before " " was "
" May ——— " " " " when " " "Stopped
Holidays

SHOWING AVERAGE COAL CONSUMPTION WITH THREE ECONOMIZER CONDITIONS

as will be seen from the accompanying monthly consumption averages per indicated horsepower per hour.

Before the Economizer Was Stopped for Boring	Pounds	When Economizer Was Stopped	Pounds	After Economizer Was Started Again	Pounds
1912 Jan.	2.02	1913 Jan.	2.07	1913 Mar.	1.97
Feb.	2.13	Feb.	2.13	Apr.	1.81
Mar.	1.99			May	1.89
Apr.	1.81	Total	4.20	June	1.87
May	1.89	Average	2.10	July	1.96
June	1.87			Aug.	1.85
July	1.83			Sept.	1.74
Aug.	2.04			Oct.	1.71
Sept	1.70			Nov.	1.69
Oct.	1.72			Dec.	1.74
Nov.	1.75				
Dec.	1.90			Total	18.23
				Average	1.82
Total	22.65				
Average	1.88				

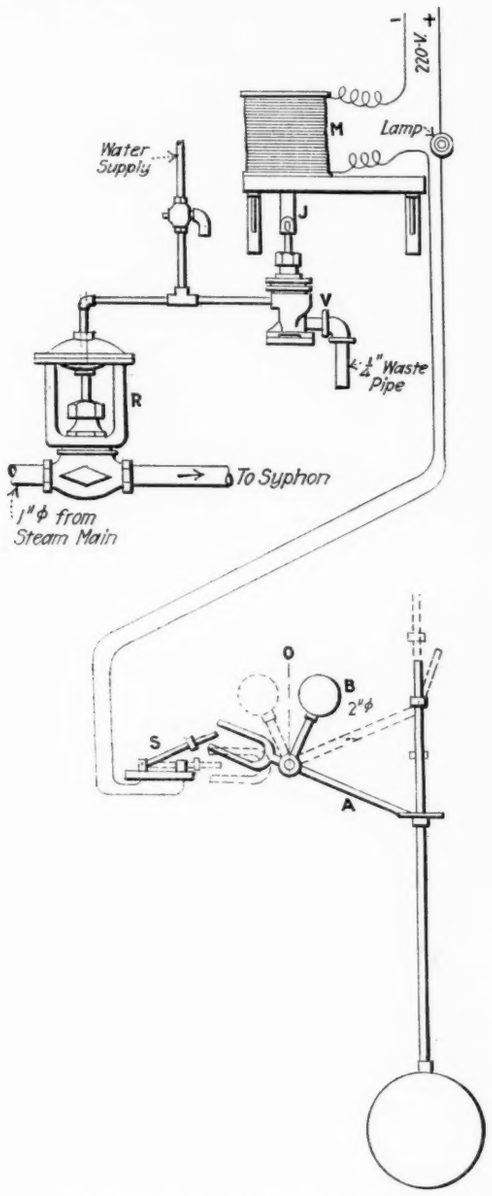
The averages when the economizer was worked before and after being bored are nearly the same, 1.22 + 1.82 = 3.70 ÷ 2 = 1.85 average. Average was 2.10 when the economizer was stopped, therefore 2.10 — 1.85 = 0.25 and 0.25 × 100 ÷ 1.85 = 13.5 per cent.

This percentage of savings corresponds to that shown by the chart, which was platted from data obtained this year.

Ahmedabad, India. S. B. R. PATEL.

Automatic Control for Siphon

A sump-hole in a mill building drained by a siphon, located in the engine-room basement 200 ft. distant, was a continual nuisance. The engineer would either neglect to start it or forget to stop it, and as a consequence, the mill basement was flooded or steam blew needlessly into the sewer. To remedy this condition, an automatic control made from parts picked up around



ARRANGEMENT OF SIPHON CONTROL

the plant was devised and installed, as shown by the illustration.

As the sump fills, the float raises the forked lever *A*, causing the lead ball *B* to move toward the center line *O*. When the ball *B* crosses the center line, it falls to the dotted position and closes the switch *S*. Current then flows from the power lines through a lamp in series with the magnet *M*, which causes the valve stem of the valve *V* to rise and allows water to flow through the waste pipe. The pressure on the diaphragm of the steam valve *R* thus being removed, allows the valve to open and steam to flow to the siphon.

The siphon continues to operate until the water level falls and the float pulls the weight *B* past the center line *O*, when it falls and opens the switch *S*. As the current is then cut off, the magnet core drops, closes the valve *V* and the water pressure builds up on the diaphragm of the valve *R*, closing the valve and shutting off the steam.

It is well to allow ⅜ in. lost motion in the joint *J*, so as to give a hammer-blow effect to the movement and overcome any tendency to stick in the packing on the valve stem. A globe valve could be used instead of the trap valve *V*, but it would not open so easily, owing to the pressure above the disk holding it to the seat. This would be no drawback if the magnet was capable of opening it.

Perth Amboy, N. J. A. QUADT.

Attention to Little Things Saved Coal

It may be of interest to readers of *Power* to know how we have effected a saving in coal slightly better than 20 per cent. Starting at the boilers, we keep the tubes clean, inside and out. The baffle bricks are kept in repair and tight, so that the gases cannot short-circuit and pass out without giving the boiler a fair chance to absorb the heat. We also adjust the damper according to the load and the conditions of the fire, so as to maintain a high percentage of CO_2 and keep the flue-gas temperature down to from 70 to 100 deg. above the temperature of the steam. Of course adjusting the damper alone will not produce high CO_2; the fires have to be closely watched to do that.

We have placed a steam-blow telltale on every steam trap. It consists of a valve and discharge pipe. As soon as a trap is found to be blowing steam, and they are tested often, it is repaired. All pipe coverings on steam, exhaust and return lines and also on all flanges, valves and traps are kept in proper repair, thus reducing condensation to a minimum.

I believe that in most plants there is a chance to make a fair showing by saving the steam after it is generated, as well as saving coal during the process of making steam. It is equally as important to keep all valve stems packed and to look after the little details, as it is to look after the economy of steam in the prime movers. We are only doing what we should do and what should be done in every power plant. To do this requires the coöperation of the chief with the men and the men with the chief.

In the larger plants the chief cannot keep in touch with all the details and know the condition of all the equipment, etc. There may be a trap blowing, due to a bypass valve leaking, or some other waste which he cannot observe on his trips through the plant. But if he has the good will and coöperation of his men, those things will be taken care of.

Binghamton, N. Y. EDWARD J. DOWD.

Distance of Bridge-Wall from Boiler Shell

I would like to obtain the opinion of engineers regarding the following:

A few weeks ago our superintendent had the bridge-walls of the boilers cut down. I told him that I thought he had made a mistake in doing so, but he didn't think so. At any rate, the firemen have had harder work to keep up steam, and they burn more coal since it was done. The boilers are hand-fired. One is 19 ft. long, 6 ft. 6 in. diameter and has 114 three-inch tubes; the other is 18 ft. long, 6 ft. diameter and has 138 two-

and-one-half-inch tubes. The rocking grates are 6 x 6 ft., and the chimney is 100 ft. high with a good draft.

The bridge-walls, as they are now, are 18 in. from the shell of the boilers and the coal burns out very fast on the back area, so much so that the firemen cannot keep any coal on the last half of the grates next to bridge-walls, no matter whether the fires are thick or thin. We carry from 75 to 100 lb. of steam.

I argue that if the bridge-wall was put back to within ten or twelve inches of the shell of the boilers, we would get better combustion, better results and burn less coal. I am not sure as to the distance, but as the superintendent is one who thinks he knows about everything and will not listen to me, I would like to have the opinions of two or three experts in regard to the distance the bridge-walls should be from the boilers in the average setting.

Ashland, N. H. ALBERT L. SMYTHE.

Right- or Left- Hand Shoveler—Which?

I wish to take exception to the explanation of a "Right-Hand and Left-Hand Shoveler," in "Inquiries of General Interest," in the Oct. 7, 1919, issue of *Power*. In this locality we have always understood

WHICH IS THE RIGHT- AND WHICH THE LEFT-HAND SHOVELER?

that a right-handed shoveler is one who supports the load with his right hand, or has his right hand nearest the shovel, and a left-handed shoveler is one who supports the load with his left hand. When using a sledge for riveting or striking, the man who grasps the handle with his right hand nearest the sledge, is a right-handed man, and vice versa, and has nothing to do with whether a person is naturally right-handed or left-handed, and the same thing applies to shoveling.

Lima, Ohio. S. M. WILLIAMS.

Drain Trenches in Pump and Condenser Pits

Progressive power-station designers and erectors now realize that pump and condenser pits should be made fit places for human beings to work in and not merely spaces for machinery. Good lighting and drainage have long been a rarity in such places. It is human nature for a man to give better attention to a machine in a clean and dry place than in a sloppy, greasy pit. Many pits are provided with one or two floor drains, but the assistance of a broom is required to complete the drainage, and drain pipes have a way of getting stopped up.

Drain trenches should be run the full length of the pits and should be covered with cast-iron grids instead of plates. The trenches should be so located that no part of the floor is more than 6 or 8 ft. from a trench, and the trenches should be about one foot wide and deep. The floor should slope toward the trenches at least one inch for every three or four feet. Drains from bedplates, glands and water seals should be piped to the trenches and not allowed to run across the floor. If proper attention is given to lighting and drainage, there will be no excuse for the operators not keeping the pit and machinery within it clean and in good order.

Providence, R. I. C. P. LAWTON.

Preventing Ice Troubles

In severe winter climates heated gatehouses are often provided at head works or at the gates of spillways of hydro-electric plants. At waste gates these houses may not cover all the gates, as it may not be necessary to keep all the gates free. Steam-heated gate chambers are also used which cover individual gates.

During the low-water period of winter many plants use all the water, and if the gates are not kept free of ice they may freeze so solid that it may take considerable time to chop them free. Under these conditions the head elevation should be maintained a sufficient distance below the dam crest to allow ample time to free enough gates to waste the water in place of it going through the turbines, in case the latter lose their load in the event of transmission-line failure.

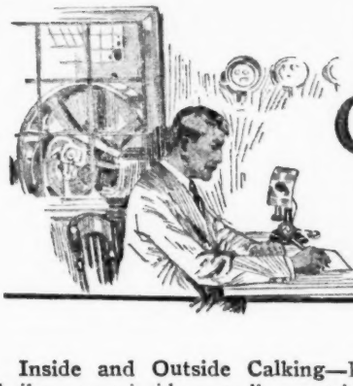
At a new installation it may be advisable to find out how long it takes to free certain gates and what tools are best adapted for the gates in question before the actual need arises. Saws, picks and axes are the tools generally used. Ice picks with three sharp prongs are excellent for such work and linemen's safety belts are handy when working on ice-covered gates.

Head-gate houses may be heated electrically. At one large plant a 50-hp. motor drives a fan which delivers air from the generator room through a chamber containing a 300-kw. electric heater to the head-gate house. Here some of the air discharges so that it blows against the racks and steelwork of the head gates at a temperature of 60 deg. C., which keeps the ice from forming.

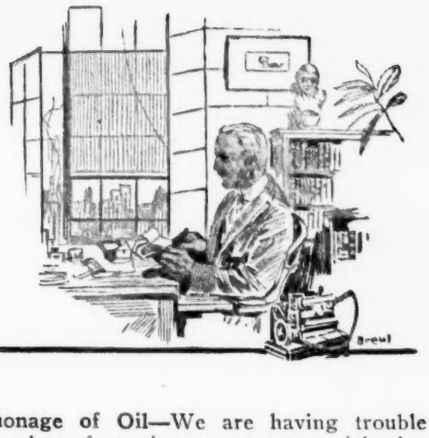
Experience indicates that if the tops of the racks are exposed to cold air above water, the steel conveys the heat from the water to the air and results in the racks having a lower temperature than the water, causing ice formation on the racks. For this reason some rack installations are designed so that the racks do not project above the water. Others are removable to allow the water to pass freely in case of anchor or frazil ice.

Charles H. Bromley's article in *Power*, June 3, 1919, covered the ice situation at Holtwood so thoroughly that any further space given to this matter would necessitate duplication, as the conditions encountered at Holtwood are typical.

Iron Mountain, Mich. L. W. WYSS.



INQUIRIES OF GENERAL INTEREST



Inside and Outside Calking—Is it customary to calk boiler seams inside as well as outside of the boiler?

L. E. F.

Calking usually is done only on the outside. In marine boilers and very carefully constructed boilers a preliminary calking is given to the inside laps, and absolute tightness is afterward secured by a calking on the outside.

Merits of Chain or Ring Methods of Lubrication—What are the merits of the chain or the ring method of supplying oil to a bearing? R. M.

These methods have the serious defect that the spent and dirty oil is returned again and again to the bearing and, unless replenished, the oil finally becomes so loaded with foreign matter that it is a less efficient method of lubrication than occasionally oiling with a squirt-can. The chain or the ring method is serviceable only in situations where the oil well is thoroughly cleaned at frequent intervals and refilled with oil free from dirt.

Blowing Off a Cut-Out Boiler—When a boiler is cut out from the main line for cleaning, should it be blown out when steam has become reduced to about 15 lb. pressure, or left standing for several days filled with cold water? A. F. B.

A boiler should not be blown off under pressure or while the brickwork is hot. Sudden reduction of pressure is injurious to the joints, and if the boiler and brickwork are not cool, the heat will bake the mud and scale in the boiler, making it difficult to clean the shell and tubes. After cutting out, there will be no advantage in allowing the boiler to stand longer than necessary for allowing it and the brickwork to become cooled.

Reporting Average Cost per Pound of Steam—The monthly report blanks of our vacuum-heating plant provide for "average cost per pound of steam in system" and "average cost per pound of steam in boiler." How should these items be computed? F. D. C.

For obtaining the "average cost per pound of steam in the system," divide the total cost of fuel, labor and other expenses for the month, by the total number of pounds of steam supplied to the coils or radiators, as ascertained by weighing or metering the water that has been discharged by the vacuum pump, less the weight of injected water. For ascertaining the "average cost per pound of steam in boiler," divide the total cost by the number of pounds of water fed to the boiler.

Trying Glass-Gage Connections—How often should the glass water gage of a boiler be blown out? M. D. T.

Glass gages should be blown out at least once a day, and as much oftener as may be found necessary to make sure they are in proper working order, and when this is done the operator should be careful to see that the cocks are open or the gage will not indicate correctly. If the lower connection is open and the top one closed, the boiler pressure will force the water too high in the glass, and if the bottom connection is closed and the top one open, the steam entering at the top will be condensed and gradually show a higher water line than actually in the boiler. Of course if both connections are closed, the gage will not indicate changes of the water level and high or low water may result without the knowledge of the fireman.

Preventing Siphonage of Oil—We are having trouble with leads on a number of starting compensators siphoning oil from the tanks. What method can be recommended to remedy this difficulty? A. A. F.

The siphoning of oil along the leads of transformers or compensators may be prevented by first removing the insulation from each lead above the highest oil level for about two inches. Then sweat the strands of the leads solidly together so that there will be no openings between them for the oil to pass through. After this is done, insulate the leads with treated linen tape, wrapping the tape very tightly around the conductor, and paint each layer with insulating varnish while wrapping. Allow the tape to extend about one inch down over the insulation on the conductor.

M. E. P. of Engine for Generation of Stated Kilowatt Load—What m.e.p. would be necessary for a 10x10-in. engine running 300 r.p.m. for operation of a 35-kw. direct-current generator when developing full capacity? G. B.

The efficiency of a generator of the given capacity under full load would be about 90 per cent, and the mechanical efficiency of an engine of the stated size and speed when driving the load given would be about 88 per cent, depending on the design, construction and adjustment. As 1 kw. = 44,240 ft.-lb. per min., the assumed efficiencies would require the steam acting on the piston to develop $\frac{44{,}240 \times 35}{0.90 \times 0.88} = 1{,}955{,}050$ ft.-lb. per min. Neglecting the reduction of piston area by the piston rod, 1 lb. m.e.p. would develop

$$(10 \times 10 \times 0.7854) \times \frac{10}{12} \times 2 \times 300 = 39{,}270 \textit{ ft.-lb. per min.}$$

so that development of 1,955,050 ft.-lb. would require

$$1{,}955{,}050 \div 39{,}270 = 49.78 \textit{ lb. m.e.p.}$$

Running Over or Under—Is more power derivable from an engine running over than running under, and if so, why? J. B.

When running over, pressure from the crosshead is on the lower guide and is due to reaction of the connecting-rod and weight of the crosshead, and as much weight of the piston rod and connecting rod as is supported by the crosshead. When running under, the pressure from reaction of the connecting-rod comes on the upper guide, but it is reduced by the weight of the crosshead and parts supported by the crosshead. Therefore in running under the guide friction is less and if anything the actual or brake power developed for the same mean effective pressure the piston would be greater. But under ordinary conditions the friction of guides is such a small percentage of engine friction that the difference of friction running over or under would be imperceptible. The principal advantage of running over is that with the pressure from the crosshead downward there is better opportunity for lubrication of the guide that receives the principal wear, better opportunity for adjusting and maintaining the alignment of the crosshead and less tendency of the crosshead to pound at the ends of the stroke.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Production of Electric Power and Consumption of Fuel by Public Utility Power Plants in the United States for the Months of February, March, April and July, 1919

Compiled by the United States Geological Survey

State	Thousands of Kilowatt-Hours Produced: By Water Power				By Fuels				Coal, Short Tons				Petroleum and Derivatives, Barrels				Natural Gas, Thousands of Cubic Feet			
	February	March	April	July	February	March	April	July	February	March	April	July	February	March	April	July	February	March	April	July
Alabama	39,341	30,275	28,488	28,442	11,059	4,907	4,477	3,689	27,026	16,467	14,836	15,458	8	8	8	8	.....	.....	.....	.....
Arizona	3,967	6,689	7,577	7,478	17,448	21,807	16,488	18,877	6,316	6,160	5,360	7,315	124,520	88,011	65,824	61,030	.....	.....	.....	.....
Arkansas	79	72	69	88	6,252	6,625	6,030	7,692	13,386	11,177	9,902	8,364	447	489	456	450	63,430	85,398	97,726	182,848
California	187,486	215,914	228,775	200,528	38,268	33,939	33,645	116,804	.....	.....	.....	.....	199,388	185,127	161,651	550,799	21,611	181,785	273,642	242,228
Colorado	13,141	14,254	15,019	14,947	17,279	17,144	14,365	12,177	41,507	44,079	36,135	27,888	100	95	98	174	.....	.....	.....	.....
Connecticut	7,043	14,884	15,804	5,943	42,589	37,469	35,525	28,182	63,942	62,234	58,094	67,513	333	323	279	213	20,766a	12,615a	11,309a	.....
Delaware	.....	.....	.....	.....	5,551	4,784	4,655	5,225	8,610	7,713	7,000	6,604	.....	17	.....	.....	.....	.....	.....	.....
Dist. of Columbia	.....	.....	.....	.....	18,094	19,331	18,457	19,221	21,418	21,440	20,983	21,412	.....	.....	.....	.....	.....	.....	.....	.....
Florida	678	892	777	942	8,582	8,789	7,776	7,731	3,424	5,594	3,056	3,193	32,714	32,025	28,785	30,745	98	151	3,780	.....
Georgia	35,909	37,264	31,404	34,224	6,054	6,082	6,200	6,595	16,529	11,934	12,009	13,560	120	120	167	2,386	.....	.....	.....	.....
Idaho	41,430	39,913	36,019	50,209	168	257	155	1,219	120	111	121	88	10	10	10	9	.....	.....	.....	.....
Illinois	15,611	15,282	16,134	15,323	198,899	207,673	194,109	183,518	335,309	350,824	318,378	304,160	3,918	2,198	2,142	984	.....	.....	.....	.....
Indiana	3,682	3,654	3,511	2,736	52,342	54,617	51,980	54,354	141,080	157,931	143,829	142,587	448	167	420	402	2,159	2,108	1,909	1,878
Iowa	44,182	48,696	48,737	51,802	23,993	24,964	23,646	24,531	85,745	79,694	72,211	69,703	787	730	743	720	.....	.....	.....	.....
Kansas	1,267	1,223	913	981	29,619	30,458	30,870	35,068	47,588	51,022	48,636	50,817	47,747	60,803	58,432	60,742	83,405	86,901	65,374	80,846
Kentucky	4	4	4	4	18,794	19,127	18,555	19,205	38,252	39,386	37,380	39,390	358	351	353	341	.....	.....	.....	.....
Louisiana	.....	.....	.....	.....	14,130	14,876	14,582	15,518	14,305	13,885	13,878	11,324	30,811	30,094	28,192	30,508	55,092	47,458	49,599	63,624
Maine	18,831	20,157	18,708	17,678	73	73	93	220	333	348	357	534	7	7	17	.....	.....	.....	.....	.....
Maryland	284	371	358	329	18,435	13,898	11,442	16,378	28,452	23,657	20,755	25,951	19	18	30	30	1,500	1,500	1,500	1,350
Massachusetts	18,698	31,365	32,322	15,163	101,799	100,030	90,601	110,467	129,171	143,525	129,877	130,506	24	14	17	21	.....	.....	.....	.....
Michigan	52,236	59,649	65,211	50,043	97,285	96,125	88,363	108,402	129,417	124,941	113,623	129,612	191	104	139	204	.....	.....	.....	.....
Minnesota	18,303	32,740	43,204	37,436	26,826	15,220	7,261	10,929	57,282	39,810	25,038	25,866	1,138	1,016	854	832	.....	.....	.....	.....
Mississippi	.....	.....	.....	.....	5,115	5,393	4,927	5,206	16,381	16,542	16,008	13,272	370	320	311	443	.....	.....	.....	.....
Missouri	4,297	5,920	4,418	2,237	37,207	40,551	36,245	39,132	86,645	89,531	82,143	82,045	33,571	21,053	19,519	18,847	.....	.....	.....	.....
Montana	68,408	77,869	77,853	83,220	883	888	821	848	5,537	5,591	5,455	4,894	530	492	488	502	1,008	960	907	912
Nebraska	748	959	1,118	1,302	15,493	16,413	16,004	16,602	29,946	30,956	29,813	31,904	3,512	3,509	3,433	3,387	.....	.....	.....	.....
Nevada	3,198	2,812	2,470	2,559	137	121	727	720	198	180	140	195	900	1,044	997	1,780	.....	.....	.....	.....
New Hampshire	4,946	5,763	5,683	4,499	2,309	2,114	1,898	3,814	5,395	3,911	3,241	5,808	20	20	3	3	.....	.....	.....	.....
New Jersey	162	197	187	151	75,665	76,412	76,642	79,546	112,366	115,711	114,137	116,944	92	103	80	79	.....	.....	.....	.....
New Mexico	57	56	80	144	1,416	1,556	1,455	1,603	4,045	4,438	3,627	4,133	1,060	1,360	1,373	1,610	.....	.....	.....	.....
New York	195,219	223,078	220,677	212,033	288,271	288,537	270,644	276,828	368,569	363,338	325,474	336,004	544	546	501	1,224	149,831	164,408	147,432	56,949
North Carolina	42,645	46,318	45,755	45,317	7,149	7,426	7,082	7,243	15,648	16,234	15,612	14,915	20	20	20	20	.....	.....	.....	.....
North Dakota	.....	.....	.....	.....	2,312	2,400	2,103	2,449	16,638	17,153	14,473	14,808	539	514	530	553	.....	.....	.....	.....
Ohio	3,053	3,932	3,565	2,378	189,041	194,937	183,702	208,240	314,873	321,643	289,610	288,658	739	842	764	689	250,488	323,320	333,684	b512,586
Oklahoma	167	183	149	161	13,080	13,796	12,989	13,826	11,136	12,578	10,075	8,717	8,109	6,300	9,921	20,057	423,813	477,050	458,496	474,930
Oregon	27,876	29,113	27,248	29,130	4,754	3,759	3,539	4,323	223	433	223	222	27,684	19,459	15,456	5,664	.....	.....	.....	.....
Pennsylvania	55,098	62,509	58,466	52,648	238,970	246,930	233,597	238,021	401,874	412,561	396,096	388,957	22	14	16	297	42,301	54,450	53,533	40,531
Rhode Island	562	1,042	726	240	28,767	18,405	16,839	19,821	29,692	22,024	20,819	22,648	.....	.....	.....	.....	.....	.....	.....	.....
South Carolina	43,899	43,394	43,287	42,649	3,876	4,010	3,676	3,480	9,844	9,540	8,811	8,281	78	82	93	102	.....	.....	.....	.....
South Dakota	2,683	3,579	4,104	3,468	2,949	3,208	1,920	2,920	7,082	8,395	4,371	6,841	3,164	3,379	3,091	3,192	.....	.....	.....	.....
Tennessee	43,640	45,222	37,999	32,316	9,774	10,680	10,405	9,164	23,726	28,724	24,710	22,156	86	84	81	82	.....	.....	.....	.....
Texas	266	284	305	191	43,070	47,616	44,816	45,537	25,330	33,963	26,618	29,269	170,905	181,397	178,033	188,691	173,695	179,760	177,778	114,148
Utah	13,135	15,463	17,434	12,405	.....	.....	.....	.....	65	61	31	.....	.....	.....	.....	.....	.....	.....	.....	.....
Vermont	13,428	18,574	19,482	11,748	173	179	187	976	542	412	246	3,909	2	2	2	2	.....	.....	.....	.....
Virginia	17,883	20,122	19,298	17,666	17,254	18,709	16,539	19,336	29,127	31,444	28,453	30,674	122	153	52	122	.....	.....	.....	.....
Washington	70,779	79,346	74,575	79,881	4,171	4,521	4,164	5,434	3,611	3,473	2,411	2,060	17,810	18,804	17,879	22,071	.....	.....	.....	.....
West Virginia	1,378	1,593	1,642	1,399	52,620	58,108	59,396	66,523	62,459	70,717	69,426	83,556	52	58	52	45	118,029	142,688	180,069	264,054
Wisconsin	32,534	47,531	48,880	41,512	32,916	33,075	24,682	27,637	69,225	74,987	53,037	46,221	644	662	565	574	.....	.....	.....	.....
Wyoming	248	172	138	179	3,315	3,603	3,249	3,386	12,450	13,384	12,242	12,752	8,470	9,062	8,840	4,008	5,278	6,208	3,129	3,481
Total	1,148,634	1,308,329	1,308,573	1,213,729	1,834,222	1,841,542	1,717,523	1,928,617	2,873,265	2,919,406	2,648,760	2,676,688	722,133	671,006	610,736	1,014,652	1,412,504	1,766,850	1,859,867	2,040,365
Total, by water power and fuels	.....	.....	.....	.....	2,982,856	3,149,871	3,026,096	3,142,346	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

(a) Artificial gas. (b) Includes 182,415.

These reports are based on returns received from about 3,000 electric-power plants engaged in public service, including central stations, electric railways, and certain other plants which contribute to the public supply. Returns were received from plants whose aggregate capacity of generators is about 90 per cent of the total installed capacity of generators of public-utility plants. Estimates of the output of plants which did not submit returns were made from available information. The figures given are subject to revision in subsequent statistical reports of the United States Geological Survey relating to power production.

Operation and Maintenance of Railroad Stationary Plants*

KEEPING soot from accumulating on tubes and flues is one of the most important steps toward economical operation. Flues should be blown at least once each eight hours, and when boilers are down for a washout they should be thoroughly cleaned with a brush or scraper. In water-tube boilers the tubes should be thoroughly blown when the combustion space is cleaned. The boilers should be blown down at least once each eight hours, and the men coming on shift should test the water columns, try-cocks and pop valves. Feed the boilers continuously, maintaining a constant water level. Regulate the draft with the stack damper rather than the ashpit doors.

When the boilers are down for a washout, be sure that they are cleaned. Rattle or turbine the tubes if necessary and scale the shell. Clean out the furnace and combustion chamber, the bridge-wall and the smokebox. See that all repairs to the furnace and combustion-chamber walls and arches are taken care of. Repair the blowoff valves and feed valves if necessary, and see that all doors are air-tight. Minor furnace and combustion-chamber repairs can be made with plastic cement, and air leaks can be stopped up with a plastic boiler covering. Stacks should be painted with an approved stack paint at least once a year.

See that nonreturn valves are kept in working order and that all valves are kept packed; paint valve stems with graphite and oil about once a week to save valve-stem packing. If the insulation is removed from the piping to make repairs, see that it is replaced promptly.

The time to clean feed-water heaters can be determined by watching the temperature of the feed water, which should never be allowed to drop below 200 deg. Carry the water level in the heater at such a point as to keep a head of water on the pump at all times, but not so high as to cause the heater to overflow continuously.

Feed pumps should be repacked once every 30 days. This insures one good pump on the job all the time.

Air compressors and power equipment should have the rods and bearings keyed up at all times. Indicate all engines and compressors frequently and take care of leaky valves and faulty settings as quickly as possible. Such equipment needs a general overhauling every three to five years. Inspect the water jackets on the compressors frequently, as they may fill up quickly with mud and scale.

The exhaust-steam heating system is the most economical device in the plant if properly operated. Almost any railroad exhaust-steam heating system should operate with satisfaction on two or three pounds pressure. A well-designed and well-operated exhaust-steam heating system will reclaim about 90 per cent of the heat in the steam, and the greater part of the other 10 per cent goes into the feed water. A vacuum of 5 to 10 in. of mercury should be sufficient, provided the return lines are tight and the traps are not leaking.

During the summer of each year all heating-system traps and sediment chambers should be removed and cleaned. See that the return lines are all in good shape and air-tight, and overhaul the vacuum pumps. If it becomes necessary during the winter to shut the heat off for a short time, be sure that all drains from the system are opened to the sewer to prevent freezing, and keep them open after the heat is again turned on until the system has been warmed up, then cut in the vacuum pump.

If loss of vacuum occurs, find out in what section the trouble lies, by isolating each section in turn; then test the pumps by shutting off the returns. Having located the section, go over the return lines in this section with a torch, which is about the simplest method for locating leaks in vacuum lines. If the leak is not located in the return lines, look for a leaky trap, by shutting the steam valve on each coil in turn.

See that all steam, air and water lines and valves are kept in repair. Do not allow pipe covering to become ragged and fall off. Do not allow pipe-line supports and hangers to become loose. Keep boiler and engine rooms clean and painted. Do not allow temporary shacks, piping and scaffolds to stand after they have served their purpose. Put in the broken window lights, rehang sagging doors, and paint the walls, piping and foundations. Make the stationary plant a clean and desirable place to work in.

Fuels and Combustion

When oil and gas are in active competition with coal, they can be burned with great economy. There are only a few places where gas is used, and the supply of natural gas is too small to make this fuel very active for commercial purposes. Burning of oil in boiler furnaces has assumed great importance during the last few years, and the continual rise in price of coal is making oil an active competitor of coal in the Middle Western territory.

Steam seems to be the favorite medium of atomization, although low-pressure air has been used with success. Any burner that will atomize the oil efficiently, with a minimum of steam consumption, will give economical results, although the design of the furnace has considerable to do with the economy. The use of preheated air (air usually heated by passing through ducts in the furnace and floor, side walls or arches) does much to increase the efficiency of oil-burning furnaces. When using oil in return-tubular settings, care should be taken to direct the flame so that it will not impinge on the boiler shell.

The use of powdered coal at this time is not recommended. It is still in the experimental stage and there is considerable danger in handling and transporting it. It is understood that the plant at Parsons, Kan., which was the pioneer in powdered-coal burning at stationary plants, has abandoned that fuel for oil.

The United States Shipping Board has been experimenting with "Colloidal" fuel for over a year, and according to all reports, has obtained good results. It consists of a fuel oil having powdered coal held in suspension by a secret "colloid" added to the mixture. "Colloidal" fuel burning presents about the same conditions as oil burning, and it can be burned in the same burners. It has all the advantages of powdered coal and none of the dangers in handling and transporting. "Colloidal" fuel is heavier than water, and when dumped upon the surface of water, it will sink, so that the fire hazard is reduced even over oil.

Smoke is usually an indication of inefficient operation, and at best is a nuisance. Smokeless combustion involves the proper and right relation of air and unburned gases, and the maintaining of a sufficiently high temperature during combustion of the gases. The proper mixing of air and gases usually involves a secondary admission of air, and the temperature is maintained usually by brickwork in the form of secondary arches, bridge-walls, etc. If secondary admission of air is used, great care should be taken to see that this admission is properly controlled, for great damage and loss of efficiency may result from its improper use. Also, remember that introduction of smoke and secondary arches results in a loss of draft, and that due allowance should be made. While "dutch oven" furnaces are recommended in some cases, there are many coals for which it is not suitable. Furnace temperatures with "dutch ovens" are always high. With a coal having ash of low fusing point, extremely high furnace temperatures are likely to result in the formation of clinkers. Keep the furnace temperatures as high as is consistent with the fusing point of the ash, but keep the combustion-chamber temperatures as high as can be obtained. There are many places where, if the "dutch oven" arch was moved out of the furnace and into the combustion chamber, a saving of fuel and higher boiler capacity would be effected.

There is no doubt that forced draft will increase the capacity of any furnace, for it increases the rate of combustion.

*Excerpts from report of Committee on Railroad Stationary Power Plants presented to eleventh annual convention of the Association of Railway Electrical Engineers.

But forced draft may become the source of great loss of economy when used inadvisedly. The maintenance cost of forced-draft equipment is also an item deserving consideration, as is furnace maintenance cost, which will be increased.

To overcome the bad features of forced draft, go a step farther and install balanced draft. There are several such systems on the market, and in choosing any one of them be sure to analyze the system completely. There are two points to consider as the basis of regulation—the load conditions, of which the steam pressure is an indication, and the furnace conditions indicated by the furnace draft. All the controlled forced-draft systems admit of regulation for load conditions by a pressure regulator which speeds up or slows down the fan, accordingly as the pressure drops or rises. As for the second point of regulation, the furnace condition is primary. So, in choosing any of the controlled- or balanced-draft systems, be sure that the furnace is used primarily as a basis of regulation.

Urges Greater Use of Niagara Power

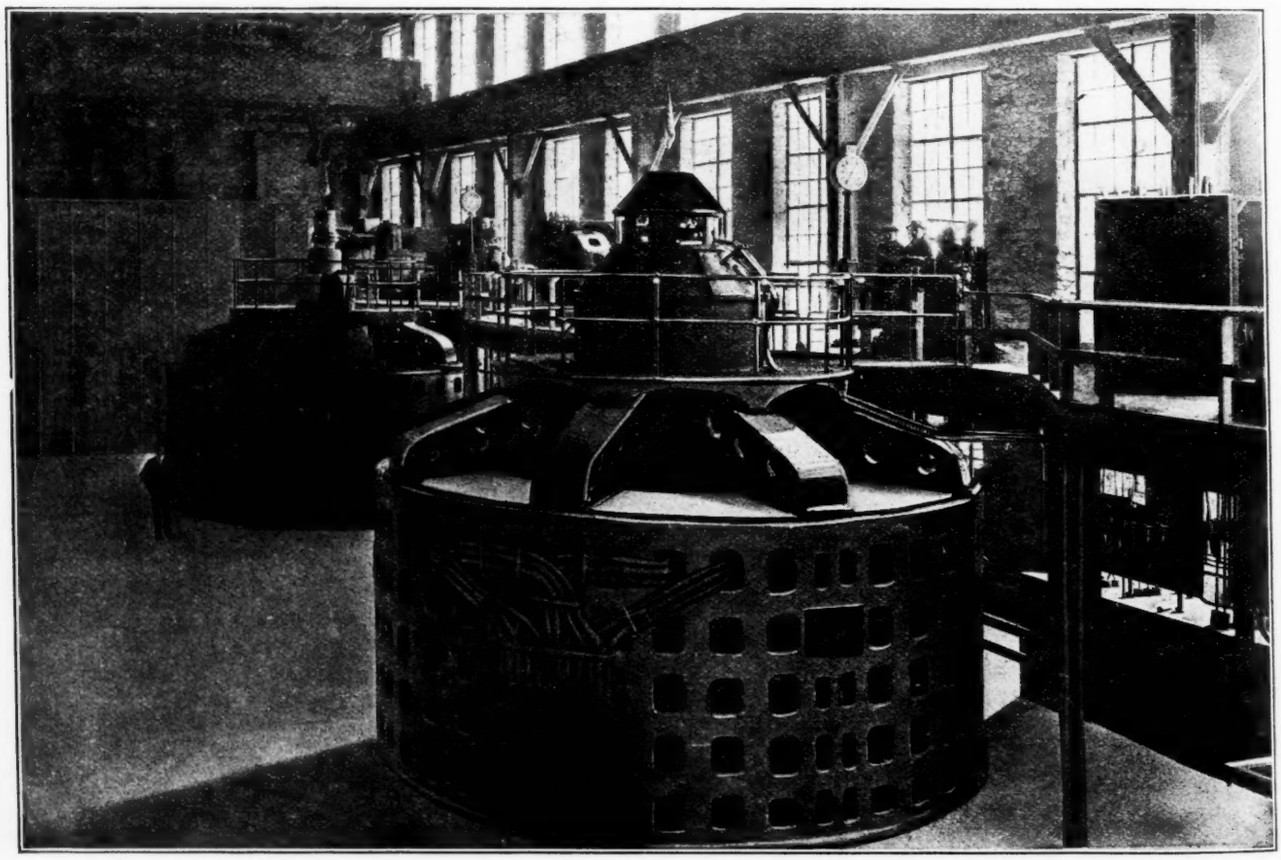
Addressing the American Electrochemical Society at Buffalo on Feb. 3, John L. Harper, chief engineer of the Niagara Falls Power Co., gave a convincing argument for further development of power at the Falls, and reviewed briefly, by means of slides, the present development, especially as pertains to the Hydraulic Plant, the recent extension of which contains the three largest water-power units in existence; namely, 40,000 hp. apiece.

Water-power propositions, said Mr. Harper, may be divided into two general classes—those in which the rate of developing the water power may be controlled by full or partial water storage, and those in which no storage is possible. To the latter class belongs Niagara power. In the first class the use of the water is controllable over certain hours of the day, or even certain seasons of the year, whereas in the second class any diminution of use represents a total loss. The ideal load for the second class of power is represented by that of the electrochemical and metallurgical processes, where the use factor is large and where the cost of power entering into the process is large compared with the cost of labor. In fact, 95 per cent of the ferro alloys of domestic manufacture are made at Niagara. Other types of load, such as light manufacturing, where the cost of power is relatively a small factor, and lighting or street-railway service, where a variable load is encountered, should, in the speaker's opinion, be left for either steam power or water power having storage facilities; or, as an alternative, the base load might be cared for by the hydro-electric power and the peak by steam power.

New York State has two major sources of hydro-electric power—the Adirondack and St. Lawrence section, and the Niagara River section. The former is somewhat removed from good transportation facilities, and in this case it would be permissible to transmit power a considerable distance to manufacturing centers. The situation at Niagara, however, is different. It is near a shipping center, both rail and water, and it would be poor engineering to transmit this power over a long distance, with the accompanying transmission costs and losses, when the industries can be located right at the source of the power.

Mr. Harper was strongly opposed to any system that would tax the people of the state for the development of hydro-electric power, from which they would derive no direct benefit. He believes that the cost of development should be borne only by the people who benefit by it through rates which they individually pay for this service, or indirectly in the price of the commodities manufactured or distributed by means of it.

The speaker threw on the screen a map showing the first survey of Niagara Falls in 1764. This showed a distinctly different contour of the falls from that of the present map and illustrated how the falls are receding year by year; on the Canadian side this recession is estimated at six feet per year. It has served to increase the length of crest by about 50 per cent during this period, and this greater length, together with the fact that the recession is wearing a channel at the middle of the falls, accounts for considerable rock showing at



TWO OF THE NEW 40,000-HP. UNITS AT THE HYDRAULIC PLANT, NIAGARA

the edges. This, it was pointed out, is what is sometimes mistaken by conservationists as an indication that less water is going over the falls. The total flow of the river is 210,000,000 ft.-sec., and Mr. Harper believes that 60 per cent could be diverted for hydro-electric purposes without marring the beauty of the falls. It would be necessary to leave 40 per cent in order to maintain the river and discharge ice in the winter time.

With a diversion of 60 per cent of the water, and the placing of concrete booms in the upper river so as to divert the water from the channel and spread it over the falls, the rocks would be completely covered and the level of the water in the river below the falls would be lowered considerably, thus having the effect of increasing the height of the falls. At present it is estimated that the depth of the river below the falls is about 200 ft. A diversion of 60 per cent of the water would make available about 3,600,000 hp.

The extension to the Hydraulic Plant, which is now nearing completion, was undertaken during the war at the request of the War Department, for emergency power, it being desired to add approximately 100,000 hp., bringing the diversion of water up to the maximum allowable by the Burton Act. The time from starting construction to the putting the first unit in service, December, 1919, was 19 months, a really remarkable record, considering the difficulties that had to be overcome in constructing the penstocks through solid rock, constructing the plant at the edge of the gorge and lowering all material and equipment over the cliff a distance of 215 feet.[1]

The three new units, two of which are now in service, are each rated at 37,500 hp., although they have carried 40,000 hp. They are of the vertical type running at 150 r.p.m. under an effective head of 215 ft. and direct-connected to 32,500-kva. three-phase 25-cycle 12,000-volt generators. A view of two of these units is shown in the illustration.

[1] *Power* expects to publish a detailed description of this plant when construction has been completed and the information released. This, it is believed, will be within two or three months.

Personals

Thomas H. Macauley, who has been manager of construction and operation of the Calgary (Canada) Municipal Railway since 1909, is now general manager of the New Brunswick Power Co.

John A. Stevens, consulting engineer in power-plant design and construction at Lowell, Mass., has opened a branch office in Fall River, to handle business in the southern New England district.

Edward C. Jones, who has been chief engineer of the gas department of the Pacific Gas and Electric Co. since 1891, has resigned to go into business for himself in San Francisco, where he has opened offices.

John Clyde Oswald, president of the Oswald Publishing Co. and publisher of the "American Printer," has been appointed vice president of the Preston Trading Co., New York City. Mr. Oswald has also been elected president of the National Paper Trades Exchange.

Robert N. Hodgson has resigned as general manager of the Binghamton Light, Heat and Power Co., and as general sales manager of the controlling company, the W. S. Barstow Co., to give his time to his own business interests. He is succeeded by R. L. Peterman, who was formerly superintendent of the utilities company at Easton, Penn.

Frank R. Towles, formerly general superintendent of the York County Light and Power Co., has resigned to become superintendent of the Cumberland County Power and Light Co., at Portland, Me. William E. Shaw, local manager of the former plant, succeeds Mr. Towles as superintendent of the electrical division, and Ralph W. Hawks succeeds Mr. Shaw as local manager.

Harry Z. Bixler, formerly chief engineer for the Youngstown (Ohio) Steel Co., and in the same capacity with the Brier Hill Steel Co. since the latter's incorporation, has resigned to identify himself with the development of what promises to be a new era in the manufacture of iron and steel in this country and throughout the world. He is succeeded by W. H. Ramage, formerly assistant chief engineer. T. M. Phillips, who was superintendent of the washed metal plant during the joint régime of the two companies, has associated himself with the same development in which Mr. Bixler is interested.

Engineering Affairs

The American Association of Engineers will hold its annual convention at St. Louis, Mo., May 10-11, with headquarters in the Planters Hotel.

The Electric Club of Chicago has opened permanent headquarters on the mezzanine floor in the Hotel Morrison. A part of the quarters is devoted to a library, which will be equipped with all the popular magazines as well as those applying to the club's own industry.

The American Society of Mechanical Engineers announces the following section meetings: Atlanta, Ga., at the Georgia School of Technology, Feb. 24; subject, illustrated lecture on "Building a 30,000-kw. Turbo-Generator Set," by H. E. Bussey. St. Louis, Mo., April 7, joint meeting of the Associated Engineering Societies of St. Louis, at which F. O. Pahlmeyer, engineer of the Heine Safety Boiler Co., will deliver an illustrated paper on the "Different Processes in the Manufacture of a Heine Boiler." Baltimore, Md., Feb. 27; subject for discussion, "Vocational Education," and many prominent speakers are expected to attend.

The Association of Iron and Steel Electrical Engineers announces the following meetings: Cleveland, Ohio, Feb. 28, at Union Electric League Rooms, Hotel Statler; E. S. Lammers will talk on "Automatic Control of Electrically Operated Blooming Mills." Pittsburgh, Penn., section: March 20; T. D. Lynch, research engineer of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, will talk on "Babbitt and Babbitting." April 17, Robert B. Treat, electrical engineer of the General Electric Co., will talk on "Grounded Neutral." On May 22 there will be an inspection of one of the largest steel plants in the state of Ohio. June 12, R. H. Keil, power engineer of Jones & Laughlin Steel Co., will talk on "Current Limit Reactance."

Miscellaneous News

The National Exposition of American Manufacturers, which was to have been held in April, 1920, at Buenos Aires, Argentine Republic, has been postponed until November, 1920, to allow more time for adequate preparations and shipments from other parts of North and South America.

The International Conference of Refrigeration, held at Paris last month, was convened in view of examining the creation of an international organism to insure common action as regards the economic affairs of each nation and efforts of scientists, economists and industrials engaged in the study of refrigerating questions. After January, 1920, the Institute will issue a monthly bulletin of information on refrigeration, edited in two languages, English and French, in which all scientific, technical and economical data sent to the Institute and appearing in all parts of the world will be classified.

The National Marine League has begun the promotion of a national publicity campaign to start the American people thinking seriously upon the problem and possibilities of a merchant marine. The campaign will culminate in National Marine Week, Apr. 12-17, and while nationwide in scope will center in New York City, where a series of celebrations and demonstrations will be given. The ceremonies for the week will be opened aboard an American built, owned, operated and manned ship in New York harbor, by Chairman Payne, of the Shipping Board, and Secretary of Commerce Alexander. The formal opening of the National Marine Exposition will be the same evening at Grand Central Palace. On Tuesday afternoon the free Marine Art Exhibit will be opened under the direction of the leading artists of the country. A feature of this exhibit will be the greatest gathering of ship models ever assembled in America. The annual dinner of the National Marine League will be held that night. Wednesday will be Shipbuilding day; Thursday, Merchant Mariners' day; Friday, Fuel and Engineering day; Saturday, Inland Waterways and Harbors day, when demonstration parades will be reviewed by Government officials.

Business Items

Yarnall-Waring Co., Philadelphia, Penn., has opened a branch office in Detroit, in the Builders' and Traders' Exchange, Penobscot Building, with Walter G. Heacock in charge.

C. F. Braun & Co., manufacturing mechanical engineers, of San Francisco, Cal., have removed their executive offices to the tenth floor of the Atlas Building, 604 Mission St., San Francisco.

The Automatic Fuel Saving Co., Philadelphia, has purchased from the Vapor Vacuum Heating Co. and George C. G. Gray the patent and goodwill of the Gray system of combustion control for power plants. The new company has adopted the name of automatic fuel saver for the system.

The Chicago Fuse Manufacturing Co. has purchased from the Otis Elevator Co. the property at the southwest corner of Fifteenth and Laflin Sts., Chicago. It is expected the company's two plants at West Congress St. and at South Throop St. will be transferred shortly to the new location.

The Maher Engineering Co., 30 North Michigan Ave., Chicago, announces the opening of a branch office at 708 Schofield Building, Cleveland Ohio, handling the distribution of Erie Engine Works engines, Dayton-Dowd Co. centrifugal pumps and Galland Henning hydraulic presses. The office will be under the management of Lincoln E. Maher.

The Collins-Lotz Co., recently formed, has opened an office at 26 Hartford Trust Building, Hartford, Conn., for the sale and application of heat and cold insulation materials of all kinds. A warehouse will also be maintined at Hartford. Mr. Collins was formerly the treasurer and manager of sales and contracts of Robt. A. Keasbey Co., New York City. Mr. Lotz was for many years manager of the Hartford office of the same company.

The Chicago Pneumatic Tool Co. announces the following appointments: Edward A. Woodworth as special railroad representative attached to the staff of manager of western railroad sales, with headquarters at Fisher Building, Chicago, Ill. Mr. Woodworth has been for several years secretary of the Committee on Standards, U. S. Railroad Administration, Washington, D. C. C. E. Laverenz as special railroad representative attached to the staff of manager of western railroad sales. Mr. Laverenz for several years was an inspector in the Ordnance Department of the U. S. Navy, and previously held positions as boilermaker and foreman of the Chicago & Northwestern and Illinois Central Railroads.

Trade Catalogs

"New Truths and Old Fallacies" is the title of a 24-page booklet just issued by the Magnolia Metal Co., New York City. It contains intimate and instructive information concerning babbitt metals, not generally known, and users and buyers will find it a useful guide in selecting such products. A copy may be had free upon request.

Laclede-Christy, St. Louis, Mo., has issued a 42-page bulletin entitled "Boiler Capacities with Chain Grates," showing the importance of fuel-bed temperatures in increasing the maximum capacity attainable, in a way that is easily understood. The booklet was compiled and edited by Loyd R. Stowe, manager of the company's stoker department, and contains much useful information on this subject.

"Fuel Oil Applied to Power Boilers" is the title of an interesting 16-page booklet recently issued by the Engineering Dept. of the Coatesville Boiler Works, Coatesville, Penn. It contains some valuable information as to the relative merits of different fuels for use under boilers of all types, as well as on the dimensions and capacity in gallons of horizontal and vertical storage tanks. A copy may be had free upon request.

"Securing Better Combustion of Midwest, Western and Southwestern Fuels" is the title of a 31-page booklet recently issued by the Green Engineering Co., of East Chicago, Ind. It is a compilation of articles that have appeared in **Power** and **Electrical World** during the last year, discussing the many problems which arise in securing efficient combustion with above mentioned fuels, and pointing out their solutions. A copy of the bulletin may be had free upon request.

The De Pere-Burton Company, Milwaukee, Wis., is now sending out upon request a 32-page loose-leaf catalog dealing with the Burton semi-sectional and De Pere improved cross-drum water tube boilers. The publication enters into the construction and the many good points of design attributed to these types of boiler and pictures their application to stationary and marine service. The adaptability of the boiler to waste-heat service is featured, and mention is made of excellent facilities in a shop that has had years of boiler experience.

The Carrick Engineering Co., Chicago, has issued a 12-page catalog, letter size, describing the Carrick Combustion Control which automatically synchronizes fuel feed and damper position to correspond with the load, holding the proper relation for efficient results. Due to a graduated movement, it takes and holds any intermediate position that is required for the load carried and instantly moves to a new position if there is a slight change in the load or steam flow, in feed water or in furnace conditions. It automatically correlates fuel and air supply by individual control of stoker engines, stoker motors, dampers, forced draft and induced draft fans. A copy of the catalog will be sent upon written request.

"Westinghouse Underfeed Stoker" is the title of a 36-page, 8½ x 11 in. booklet, with an attractive three-color cover, just issued by the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn. Under the head of Details of Construction, it gives a comprehensive description of the leading features of design contributing to the efficiency and reliability of operation. The interconnection of grates and tuyeres and the arrangement of brackets, gears and fuel deflecting plates, are clearly described. Taking up the principles of operation, the circular explains, by use of sectional cuts and charts, the distinctive features of the Westinghouse zone system of air distribution. The subjects of efficiency and capacity are taken up together with flexibility. Curves setting forth extensive performance data relative to these subjects and others are used to amplify the text. Under the subjects of the coal-saving problem and fuel burning equipment of modern power stations, an interesting and instructive array of information is given for the benefit of those who have the operation of stokers in charge. A large list of representative installations making use of these stokers is given. The booklet is illustrated throughout.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$8.20@$8.65
Stove	8.45@ 9.05
Chestnut	8.55@ 9.05
Pea	7.05@ 7.40
Buckwheat	3.60@ 3.80
Rice	2.30@ 2.50
Barley	1.25

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2.85@$3.35	$3.15@$3.60
F.o.b. Philadelphia, gross tons	5.05@ 5.60	5.35@ 5.90
F.o.b. New York, gross tons	5.40@ 5.95	5.75@ 6.25
Alongside Boston (water coal), gross tons	7.00@ 7.75	7.60@ 8.00

Pocahontas and New River are practically off the market for coastwise shipment, but are quoted at $6.25@$7.00.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports are as follows:

Anthracite

	Company Coal
Broken	$7.80@$8.25
Egg	8.20@ 8.65
Stove	8.45@ 9.05
Chestnut	8.55@ 9.05
Pea	7.05@ 7.40
Buckwheat	5.15
Rice	4.50
Barley	4.85
Boiler	4.85

Bituminous

Government prices at mines:	Spot
South Fork (best)	$3.25@$3.50
Cambria (best)	3.00@ 3.25
Cambria (ordinary)	2.60@ 2.90
Clearfield (best)	3.00@ 3.25
Clearfield (ordinary)	2.60@ 2.90
Reynoldsville	2.85@ 2.90
Quemahoning	3.25@ 3.50
Somerset (medium)	3.00@ 3.25
Somerset (poor)	2.50@ 2.75
Western Maryland	2.50@ 2.75
Fairmont	2.25@ 2.50
Latrobe	2.60@ 2.90
Greensburg	2.75@ 3.00
Westmoreland ¾ in.	3.40@ 3.50
Westmoreland run-of-mine	2.75@ 3.00

PHILADELPHIA—Bituminous coal prices vary according to district from which they are mined. For ordinary slack the price is $2.45@$2.55; lump, $3.00@$3.35, at the mines.

BUFFALO—

Anthracite

	On Cars, Gross Ton	At Curb, Net Ton
Grate	$8.55	$10.80
Egg	8.80	10.65
Stove	9.00	10.85
Chestnut	9.10	10.85
Pea	7.75	9.30
Buckwheat	5.70	7.75

Bituminous

Allegheny Valley	$4.80
Pittsburgh	4.65
No. 8 Lump	4.65
Mine Run	4.80
Slack	4.10
Smokeless	4.60
Pennsylvania Smithing	5.70

CLEVELAND—Prices of coal per net ton delivered in Cleveland are:

Anthracite

Egg	$12.25@$12.40
Chestnut	12.50@ 12.70
Grate	12.25@ 12.40
Stove	12.40@ 12.60

Pocahontas

Mine-run	$7.50

Domestic Bituminous

West Virginia split	$8.50
No. 8 Pittsburgh	$6.60@ 6.90
Massillon lump	8.25@ 8.50
Coshocton lump	7.15

Steam Coal

No. 6 slack	$5.25@$5.50
No. 8 slack	5.10@ 5.50
Youghiogheny slack	5.25@ 5.50
No. 8 ¾ in.	5.70@ 6.00
No. 6 mine-run	5.25@ 5.50
No. 8 mine-run	5.75

Only coal available is mine-run Pocahontas.

MIDDLE WEST—Chicago quotations, F.o.b. cars at mine:

	Springfield, Carterville, Williamson, Franklin, Saline, Harrisburg	Fulton, Peoria	Grundy, La Salle, Bureau, Will
Lump	$2.55@$2.70	$2.95@$3.10	$3.25@$3.40
Washed	2.75@ 2.90	.....	3.45@ 3.60
Mine run	2.35@ 2.50	2.75@ 2.90	3.00@ 3.15
Screenings	2.05@ 2.20	2.35@ 2.50	2.75@ 2.90

New Construction

PROPOSED WORK

Me., Mt. Desert Island—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will soon receive bids for the construction of a frame building and for the installation of heating, plumbing and electric light systems at the Naval Transmitting Station, here.

Conn., New Haven—The State Bd. of Health, 308 Church St., Hartford and Bilderbeck & Langdin, Archts., Manwaring Bldg., New London, will receive bids about March 1 for the construction of a 3 story 51 x 111 ft. laboratory and experimental station on Highland St. A vacuum steam heating system, including new L.P. boilers, hot water supply and refrigerating equipment, will be installed in same. Total estimated cost, $125,000.

N. Y., Brooklyn—The Amer. Mfg. Co., Noble and West Sts., is having plans prepared for the construction of a 2 story, 150 x 440 ft. warehouse at 24 Greenpoint Ave. A steam heating system will be installed in same. Total estimated cost, $155,000. W. Higginson, 18 East 41st St., New York City, Archt. and Engr.

N. Y., Brooklyn—The Brooklyn Retail Butchers Corp., 3285 Fulton St., plans to build a 3 story, 130 x 135 ft. ice plant and storage house on Atlantic Ave. and Ft. Greene Pl. A steam heating system will be installed in same. Total estimated cost $400,000. A. Rosen, Pres.

N. Y., Syracuse—The Onondaga Milk Producer's Coöperative Association, S. A. and K. Bldg., has awarded the contract for the installation of electrical work in its plant on Burnet Ave., to the Hughes Electrical Corp., 413 South Clinton St. One 75 hp., one 25 hp., two 15 hp., two 5 hp., seven 1 hp., one 7½ hp., four 10 hp., eight 2 hp., and four 2 hp. motors will be installed in same. Cost to exceed $10,000.

Pa., Scranton—Edward H. Davis and George M. D. Lewis, Associate Archts., Union Natl. Bank, are preparing plans for the construction of a 5 story, 25 x 100 ft. store building. A steam heating system will be installed in same. Total estimated cost, $125,000. Owner's name withheld.

Pa., Scranton—The Welfare League is having plans prepared for the construction of a 1 story, 100 x 100 ft. private school on Wabash St. A steam heating system will be installed in same. Total estimated cost, $85,000. Edward H. Davis and George M. D. Lewis, Union Natl. Bank Bldg., Archts.

Md., Highlandtown (Baltimore P. O.)—The Crown Cork and Seal Co., 1511 Guilford Ave., has awarded the contract for the construction of a 1 story, 30 x 40 ft. transformer house on Eastern Ave., to H. C. Barnes, 2631 Wilkens Ave. Estimated cost, $6,000.

S. C., Columbia—The State Legislature will appropriate $50,000 for repairs and installation of heating plants in the several buildings on the campus of the University of South Carolina.

Tenn., Chattanooga—The Thatcher Spinning Co., 2714 East 18th St., has awarded the contract for the construction of an addition to its spinning plant, to the Turner Constr. Co., 244 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $1,200,000.

O., Bloomville—The Bd. Educ. plans to construct a 2 story, 80 x 126 ft. school. A steam heating system will be installed in same. Total estimated cost, $110,000. Glass & Austin, Grand Theatre Bldg., Columbus, Archts.

O., Cleveland—The Cleveland Railway Co., Leader-News Bldg., plans to construct a 1 story power sub-station on Denison St., Lorain Dist. Estimated cost, $200,000. Mr. Radcliffe, Mgr. L. P. Crocelius, 700 Leader-News Bldg., Engr.

O., Cleveland—The Cleveland Telephone Co., c/o R. Pate, Engineers Bldg., will receive bids in the spring for the construction of a 2 story, 97 x 145 ft. telephone exch. building on Dille Rd. A steam heating system will be installed in same. Total estimated cost, $250,000. A. N. Symes, Engineers Bldg., Engr.

O., Cleveland—S. Cowan, Society for Savings Bldg., is having plans prepared for the construction of a 4 story, 140 x 240 ft. family hotel on East 105th St. and Ansel Rd. A steam heating system will be installed in same. Total estimated cost, $400,000. S. H. Weiss, 1032 Schofield Bldg., Archt.

O., Cleveland—The city received only bid for the installation of a heating system in the bath house, here, from the Ohio Heating & Pipe Bending Co., 1063 West 11th St., $33,153.

O., Cleveland—The East End Chamber of Commerce had plans prepared for the construction of an 8 story, 80 x 120 ft. commercial building at East 105th St. and Superior Ave. A steam heating system will be installed in same. Total estimated cost, $400,000. Address S. H. Kennard, 10708 Superior Ave.

O., Cleveland—G. A. Tenbusch, Union Bldg., is having plans prepared for the construction of a 4 story hotel at 1906 East 105th St. A steam heating system will be installed in same. Total estimated cost, $250,000. W. S. Ferguson Co., 1900 Euclid Ave., Archts.

O., Columbus—G. R. Bassett, Archt., Central Natl. Bank Bldg., will soon award the contract for the construction of a 3 story, 60 x 188 ft. salesroom on 9th and Broad Sts., for the Ohio Sales Co., 771 North High St. A steam heating system will be installed in same. Total estimated cost, $150,000.

O., Grafton—The village will receive bids about April 15 for the construction of a waterworks system, including an 18 x 20 ft. pump house, 2 deep well pumps, etc. Total estimated cost, $35,000. R. Winthrop Pratt, Hippodrome Bldg., Cleveland, Engr.

O., Kent—The Bd. Educ. will receive bids about April 1 for the construction of a 3 story, 100 x 200 ft. high school. A steam heating system will be installed in same. Total estimated cost, $250,000. Mills & Millspaugh, 67 East Long St., Columbus, Archts.

Mich., Atlas—The city engaged Van Leyen, Schilling & Keough, Archts. and Engrs., 1115 Union Trust Bldg., Detroit, to prepare preliminary plans for the construction of a 2 story hospital. A steam heating system will be installed in same. Total estimated cost, $150,000.

Mich., Battle Creek—The city plans to install a centrifugal pump, air lift and electric motor at the pumping station.

Mich., Detroit—A syndicate headed by C. F. Clippert, 2051 West Grand Blvd., is having plans prepared for the construction of a 2 story, 130 x 200 ft. theatre and office building along the Grand River and West Grand Blvd. Steam heating apparatus, with forced ventilating system, etc., will be installed in same. Total estimated cost, $2,000,000. C. W. and G. L. Rapp, 190 North State St., Chicago, Archts.

Mich., Ecorse—G. W. Graves, Archt., 43 John R. St., Detroit, will receive bids until Feb. 20 for the construction of a 2 story, 96 x 200 ft. school on Webster and State Sts., for the St. Francis Xavier Parish. A steam heating system will be installed in same. Ammerman & McColl, 2348 Penobscot Bldg., Detroit, Engrs.

Mich., Lansing—The City Light & Water Bd. plans to build the first unit of an electric power station to have a capacity of 10,000 kw., ultimate capacity, 40,000 kw., on Division St. Modern power plant equipment, including conveyors for coal and ashes, automatic stokers, boilers with turbine engine to run generator, will be installed in same. Total estimated cost, $500,000. G. G. Crane, City Hall, Mgr.

Mich., Port Huron—A. B. Parfet, Military St., plans to construct a 2 story 100 x 250 ft. service station. A steam heating system will be installed in same. Total estimated cost, $100,000.

Mich., Redford—W. E. N. Hunter and Neil C. Sorenson, Archts., Chamber of Commerce, Detroit, will receive bids until March 20 for the construction of a 1 story, 60 x 150 ft. church on Grand River Ave., for the Redford Methodist Episcopal Congregation. A steam heating system will be installed in same. Total estimated cost, $150,000.

Mich., Wyandotte—The Bd. Educ. will soon award the contract for the construction of a 2 story, 150 x 350 ft. high school on Superior St. Steam heating and ventilating systems will be installed in same. Total estimated cost, $400,000. B. C. Wetzel & Co., 2317 Dime Bank Bldg., Detroit, Archts.

Ill., Vandalia—The city will soon award the contract for the construction of an electric light and power plant. Work involves the installation of one 300 hp. water tube boiler, breeching grates, fittings, one steam engine to operate 300 kva. generator, one 300 kva. directed connected generator and one 15 kw. exciter, etc. Fuller & Beard, Chemical Bldg., St. Louis, Mo., Engrs.

Ill., Wauconda—The city plans to build a system of 10 to 24 in. storm and sanitary sewers, also a water plant including a pumping plant, etc. J. L. Pickens, Kankakee, Engr.

Wis., Milwaukee—H. A. Kulas, Archt., 883 Windlake Ave., is preparing plans for the construction of a 2 story, 50 x 80 ft. factory and a 20 x 50 ft. boiler house. A high pressure boiler will be installed in same. Owner's name withheld.

Wis., St. Francis (Milwaukee P. O.)—The Milwaukee Electric Ry. & Light Co., Pub. Serv. Bldg., is having preliminary plans prepared for the construction of a 185 x 400 ft. power house. Generators, engines, boilers, etc., will be installed in same. Estimated cost, between $500,000 and $700,000. R. H. Pinkley, Engr.

Minn., Chisholm—E. Drew, Secy. of Bd. Educ., will soon award the contract for the construction of a 3 story, 72 x 147 ft. grade school on 1st Ave. A steam heating system will be installed in same. Total estimated cost, $200,000. W. T. Bray, Exch. Bldg., Duluth, Archt. and Engr.

S. D., Brookings—P. J. Erie, Clk. Bd. Educ., will soon award the contract for the construction of a 2 story, 152 x 176 ft. high school. A steam heating system will be installed in same. Total estimated cost, $200,000. Tyrie & Chapman, Auditorium Bldg., Minneapolis, Minn., Archts. C. L. Pillsbury Co., Metropolitan Life Bldg., Minneapolis, Minn., Engrs.

Cal., Benicia—The Eng. Dept. of Benicia Arsenal has prepared plans for motorizing the mechanical shop, requiring about forty 5 to 35 hp. motors. E. P. O'Hern, Commandant.

Cal., Los Angeles—The California Walnut Growers Assn., 1326 East 7th St., is having plans prepared for the construction of a 7 story, 100 x 150 ft. warehouse and packing building on 7th and Mill Sts, Conveyors, elevators, etc., will be installed in same. Total estimated cost, between $150,000 and $200,000. A. C. Martin, 430 Higgins Bldg., Archt.

Cal., Newport Beach—The Southern California Edison Co., 120 East 4th St., Los Angeles, will build a sub-station, cost, $20,000, and a 20 mi. auxiliary transmission line from here to San Jose Capistrano, cost, $30,000.

Ont., Havelock—The Hydro-Electric Commission of Ontario, 190 University Ave., Toronto, has submitted a by-law to the taxpayers for the construction of the hydro-electric lighting and power system. About 300 house service meters will be installed. Estimated cost, $28,000. F. A. Gaky, Engr.

Ont., London—The Greene Swift Co. will receive bids until March 15 for the construction of a 3 story, 100 x 148 ft. clothing factory on Talbot St. A steam heating system will be installed in same. Total estimated cost, $125,000. W. G. Murray, Dominion Savings Bldg., Archt.

Ont., Toronto—The Bd. Educ. plans to construct 2 and 3 story additions to the various schools in the city. Vacuum steam heating systems will be installed in same. Total estimated cost, $1,500,000. W. W. Pearse, 155 College St., Mgr.

Ont., Toronto—The Westminster Presbyterian Church, 47 Bloor St., E., plans to rebuild the 1 and 2 story church and Sunday school recently destroyed by fire. A steam heating system will be installed in same. Total estimated cost, $165,000.

Ont., Windsor—M. A. Dickinson, City Clk., will soon award the contract for furnishing a motor driven street flusher, 1,000 gal. capacity, with 4 flushing nozzles and 2 sprinkling heads, centrifugal or rotary gear pump to be operated by separate motor or engine. Estimated cost, $15,000. M. E. Brian, City Hall, Engr.

CONTRACTS AWARDED.

Mass., Boston—A. Rosenthal, 1035 O. S. Bldg., has awarded the contract for the construction of an 11 story, 100 x 120 ft. office building on Atlantic Ave., to Gascoigne & Lindenthal, 43 Tremont St. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

N. Y., Arverne—A. Messer, 66 East 104th St., New York City, has awarded the contract for the construction of a 3 story, 80 x 100 ft. hotel on Cedar Ave., to Carucci & Wolpert, 186 Remsen St., Brooklyn. A steam heating system will be installed in same.

N. Y., Bronxville—The Village Investing Co., Arcade Studios, will build a 1 story, 25 x 30 ft. power house on Fairfield Rd. A steam heating system will be installed in same. Total estimated cost, $25,000. Work will be done by day labor.

N. Y., Brooklyn—Humbert & Andrews, 646 Dean St., will build a factory for manufacturing preserves, on Vanderbilt Ave. and Bergen St. A steam heating system will be installed in same. Total estimated cost, $120,000. Work will be done by day labor.

N. Y., Long Island City—The Astoria Light & Power Co., Shore Rd., Astoria, has awarded the contract for the construction of an office and loft building on Van Alst Ave., to Bartlett-Hayward Co., 100 B'way, New York City. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

N. Y., New York—The Amer. Surety Co., 100 B'way, has awarded the contract for the construction of a 21 story office building at 96 B'way, to Cauldwell-Wingate Co., 331 4th Ave. A steam heating system will be installed in same. Total estimated cost, $1,500,000.

N. Y., New York—Clarence Davies, 51 East 42nd St., has awarded the contract for the construction of a 100 x 125 ft. theatre on Burnside Ave. and Walton St., to Patrick Murphy, 371 East 144th St. A steam heating system will be installed in same. Total estimated cost, $200,000.

N. Y., New York—The Exchange Buffet Corp., 52 William St., has awarded the contract for the construction of a 2 story restaurant and store building at 17-23 John St., to Cauldwell-Wingate Co., 331 4th Ave. A steam heating system will be installed in same. Total estimated cost, $250,000.

N. Y., New York—The Forty-eighth St. Co., 241 West 43rd St., will build an 8 story, 100 x 100 ft. printing building at 331 West 44th St. A steam heating system will be installed in same. Total estimated cost, $400,000. Work will be done by day labor.

N. Y., New York—The Interborough Rapid Transit Co., 165 B'way, will build a 1 story, 50 x 90 ft. power house on Westchester Ave (Bronx Boro.). A steam heating system will be installed in same. Total estimated cost, $50,000. Work will be done by day labor.

N. Y., New York—The T. Klein Constr. Co., Inc., 652 West 185th St., will build a 1 story, 199 x 385 ft. garage on 5th Ave., between 136th and 137th Sts. A steam heating system will be installed in same. Total estimated cost, $150,000. Work will be done by day labor.

N. Y., New York—The Realty Managers, Inc., 200 B'way, will build a 1 story, 20 x 300 ft. store building on Jerome and Davidson Aves. (Bronx Boro.). A steam heating system will be installed in same. Total estimated cost, $200,000. Work will be done by day labor.

N. Y., Syracuse—The Onondaga Milk Producers' Coöperative Assn., S. A. and K. Bldg., has awarded the contract for the installation of heating and plumbing systems in its plant, to W. B. Goldie, 274 James St. Two 200 hp. boilers with a low and high pressure steam line for radiation will be installed in same. Total estimated cost, $40,000.

Pa., Altoona—The Altoona School Dist. plans an election to vote on a $1,000,000 bond issue, $800,000 of which will be used for the construction of a 3 story, 200 x 250 ft. junior high school on 14th St and 5th and 6th Aves., including a power plant capable of heating this building and present building, together with 4 steam systems for grade schools. C. M. Piper, Secy.

Pa., Johnstown—The Johnstown Terminal Warehouse, Johnstown Trust Bldg., has awarded the contract for the construction of a 5 story, 250 x 132 ft. warehouse and storage house on Maple St., to William Steele Sons Co., 16th and Arch Sts., Phila. Total estimated cost, $300,000.

Pa., Leola—N. E. Martin is in the market for 100 and 150 hp. return tube boilers with lap seam good for 50 lbs. working pressure.

Pa., Philadelphia—Sears Roebuck & Co., Arthington and Homan Aves., Chicago, has awarded the contract for installing six 500 hp. steam boilers, one 300 kw., engine drive, 220 volt d.c. generator, one 750 kw., engine drive, 220 volt d.c. generator and one 1,500 kw., geared turbine, 220 volt d.c. generator in the proposed new plant, here, to Comstock & Co., Inc., 30 North Michigan Ave., Chicago.

Md., Baltimore—A. H. Kuhlemaun Co., 2961 Frederick Ave., has awarded the contract for the construction of a 3 story, 75 x 200 ft. oleomargarine factory, to W. L. and G. H. O'Shea, 29 B'way, New York City. A steam heating system will be installed in same. Total estimated cost, $100,000.

W. Va., Elkins—The city plans to construct a pumping station and filtration plant. Estimated cost, $130,000.

Ga., Atlanta—R. S. Armstrong & Bro., 676 Marietta St., is in the market for hoisting engines, 7 x 10 and 1¼ x 10 cylinders.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., has awarded the contract for installing a steam heating system in the proposed school addition on St. Clair Ave. and Ruple Rd., to the J. Roemer Heating Co., East 22nd St., at $16,960. Noted Jan. 20.

O., Cleveland—The city has purchased a site on Starkweather Ave., opposite Lincoln Park, and plans to build a 2 story, 76 x 76 ft. bath house on same. A steam heating system will be installed in same. Total estimated cost, $100,000. Ed. Shattuck, Purch. Agt. F. H. Betz, 604 City Hall, Archt.

O., Columbus—H. C. Godman Co., 31 North 4th St., has awarded the contract for the construction of a 3 story, 45 x 187 ft. shoe factory on Thurinan Ave., to H. H. Carr, 2582 West Broad St. A steam heatink system will be installed in same. Total estimated cost, $100,000.

O., Dayton—The Peckham Coal & Ice Co., Daller St., has awarded the contract for the construction of a 1 story, 100 x 110 ft. ice plant on Linden Ave., to the A. C. Bishop Contg. Co., Guardian Bldg., Cleveland. Estimated cost, $50,000.

Ind., Vincennes—The City Clerk is in the market for additional machinery for the municipal light plant, including 2 high pressure boilers, one 500 kw. turbine driven generator, automatic coal stokers and conveyors. A bond issue for $70,000 has been authorized for the above. Ezra Mattingly, City Attorney.

Mich., Detroit—The First and Old Detroit Natl. Bank, Ford Bldg., has awarded the contract for the construction of a 24 story, 169 x 186 ft. office building on Woodward Ave. and Cadillac Sq., to the Foundation Co., 233 B'way, New York City. Steam heating equipment will be installed in same. Total estimated cost, $4,000,000.

Mich., Detroit—Ben Robinson, Penobscot Bldg., has awarded the contract for the construction of a 5 story, 80 x 100 ft. hotel on Abbott St., to Shank & Co., 38 South Dearborn St., Chicago, Ill. A steam heating system will be installed in same. Total estimated cost, $350,000.

Mich., Detroit—Ben Robinson, Penobscot Bldg., has awarded the contract for the construction of an 8 story, 144 x 200 ft. hotel on Woodward Ave., to Shank & Co., 38 South Dearborn St., Chicago, Ill. Steam heating, ventilating and refrigerating systems will be installed in same. Total estimated cost, $900,000.

Mich., Grand Rapids—The Knott Realty Co., Commerce Ave., has awarded the contract for the construction of a 5 story, 50 x 100 ft. mercantile building on Commerce Ave. and Island St., to Owen Ames, Kimball Co., 42 Pearl St. A steam heating system will be installed in same. Total estimated cost, $75,000.

Ill., Chicago—The Flexible Steel Lacing Co., 522 South Clinton St., is having plans prepared for the construction of a 1 story, 200 x 200 ft. factory on Polk St. and the Belt Line R. R. A steam heating system will be installed in same. Total estimated cost, $200,000. W. G. Carnegie, 189 West Washington St., Archt.

Ill., Marion—The Bd. Supervs. of William Co. is having plans prepared for the construction of a 3 story, 80 x 100 ft. court house. A steam heating system will be installed in same. Total estimated cost, $250,000. N. S. Spencer & Sons, 37 West Van Buren St., Chicago, Archts.

Ill., Moline—Charles D. Wyman, 11th Ave. and 8th St., has awarded the contract for the installation of a steam heating system in the proposed 4 story, 56 x 125 ft. store building on 5th Ave. and 11th St., to the Moline Heating Co. Total estimated cost, $125,000.

Wis., Milwaukee—Philip Schwab Co., 16th and Canal Sts., has awarded the contract for the construction of a 1 story, 60 x 200 ft. boiler shop on Canal St., to Riesen Bros. Co., 86 Michigan St. Estimated cost, $50,000.

Wis., Sheboygan Falls—The city, c/o S. DeLong, Mayor, has awarded the contract for furnishing 1 air pumping unit, piping, compressor motor, air receiver with automatic control and 2 ore centrifugal pumps, 450 gal. per min. direct connected to motor of proper design, to the Indiana Air Pump Co., 812 Indiana Pythian, Indianapolis, at $10,824.

Minn., Minneapolis—The Orpheum Theatre Co., 21 South 7th St., is having plans prepared for the construction of a 4 story theatre on Hennepin Ave. and 9th St. A steam heating system will be installed in same. Total estimated cost, $800,000.

Minn., Renville—The Bd. Educ. is having preliminary plans prepared for the construction of a 2 story school. A steam heating system will be installed in same. Total estimated cost, $250,000. A. R. Holmberg, Clk. Croft & Boerner, 833 Palace Bldg., Minneapolis, Archts.

Neb., Ord—Valley Co. has awarded the contract for the installation of a steam heating system in the proposed 3 story, 78 x 101 ft. court house, to John A. Anderson, 2404 Leavenworth St., Omaha, at $33,729.

Neb., West Point—The School Bd. will soon award the contract for the construction of a 2 story, 80 x 175 ft. high school. A separate contract for installing a heating system will be let. Ellery Davis, 515 Security Mutual Bldg., Lincoln, Archt.

Mo., Leadwood—The St. Joseph Lead Co., 61 B'way, New York City, has awarded the contract for the construction of a 1 sory power house, to Stone & Webster, 120 B'way, New York City. A steam heating system will be installed in same. Total estimated cost, $700,000.

Tex., Dallas—Reilly & Hall., Archts. and Engrs., 749 5th Ave., New York City, are preparing plans for the construction of a 20 story office building, here. A steam heating system will be installed in same. Total estimated cost, $2,500,000. Owner's name withheld.

Cal., Berkeley—The Bd. Educ. will soon award the contract for the construction of a 3 story, 64 x 301 ft. and an 80 x 301 ft. high school on Grove and Milvia Sts. A steam heating system will be installed in same. Total estimated cost, $400,000. William C. Hays, First Natl. Bank Bldg., San Francisco, Archt.

Cal., Whittier—The city has awarded the contract for furnishing 2 electrically driven centrifugal pumps for the proposed waterworks system, to the Byron-Jackson Iron Wks., 336 East 2nd St., Los Angeles, at $6,855. Noted Feb. 9.

Ont., Ottawa—The Bd. Educ. is having plans prepared for the construction of a 2 story school. A vacuum steam heating system with coils for heating ventilating air will be installed in same. Total estimated cost, $250,000. W. C. Beattie, Elgin St., Archt.

NEW INSTALLATIONS IN POWER

Ont., Ottawa—The city is in the market for one 75 hp. electric motor and an oil pump for road oil work.

N. F., Kingwell, P. B.—Rodway Bros are in the market for marine engines and motor engines.

Sask., Saskatoon—The Electric Light & Power Dept., City Hall, plans to install a 6,000 kva. west turbo generator. J. R. Cowley, Electrical Engr.

Alta., Calgary—The Municipal Electric Light & Power Dept. plans to construct an addition to boiler plant and ash handling. J. Curliss, City Hall, Mgr.

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